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CONTENTS

No. 1, January, 1953

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The Science of Colloids	Ernst A. Hauser	1
The Spectrum of the Harmonic Oscillator	E. J. McShane	7
Lipotropic Action of Vitamin B ₁₂ in the White Rat	J. C. F. Forbes and O. Petterson	11
Compressible Viscous Fluids	V. G. Szebehely	14
Experiences of the Multiphasic Screening Program from a Laboratory Standpoint in Richmond, Virginia	W. A. Dorsey and W. J. Williams	19
News and Notes		23

No. 2, April, 1953

(Mailed April 27, 1953)

Fundamental Characteristics of Jet Propulsion Engines.....M. J. Zucrow		41
Characters of Systematic Importance in the Family Branchiobdellidae (Oligochaeta)	Perry C. Holt	57
The Chromosomes of the Polygyrid Snail, <i>Allogona profunda</i>	Ladley Husted and Paul Randolph Burch	62
Note on Egg-laying of the Four-toed Salamander, <i>Hemidactylium scutatum</i> (Schlegel), in Eastern Virginia	Ollie King Goodwin and John Thornton Wood	65
News and Notes		67
Program of the Thirty-First Annual Meeting of the Virginia Academy of Science		76

No. 3, July, 1953

(Mailed August 10, 1953)

Recent Experiments on the Ferromagnetic Deflection of Mu-Mesons and Electrons	Stephan Berko and Frank L. Hereford	101
Observations on the Life History of <i>Hesperocorixa interrupta</i> (Say)	Marvin L. Bobb	111
Large Elastic Bending of Cantilevers with Hydrodynamic Loading	Phillip Eisenberg and L. Fogel Whicker	116

505.73
.V81

Virginia Bryophytes Collected by Bernard Mikula	Paul M. Patterson	125
Electron Microscopic Analysis of Iron Oxide Pigments	Ralph R. Wright and William G. Dechant	129
Additional Records of the Occurrence of the Freshwater Jellyfish, <i>Craspedacusta sowerbii</i> , in Virginia	Horton H. Hobbs, Jr. and Charles H. Page	137
Justus Henry Cline, The Conservationist-Geologist of Virginia	Marcellus H. Stow	139
News and Notes		140

No. 4, September, 1953

Proceedings for the Year 1952-1953

Minutes of the Thirty-First Annual Meeting, May 6, 7, 8, 9, 1953

Detailed Table of Contents

162

SUBJECT INDEX

- Allogona* 62, 63, 64
profunda 62
ptycophora 62
townsendiana 62
Ambystoma opacum 65
 Annual Meeting, 31st
 Notes 23
 Program 76, 166
Atrichum crispum 126
 Awards
 Jefferson Medal 164
 J. Shelton Horsley 24, 164
 Bequest Form 325
Bdellodrilus illuminatus 60
Branchiobdella 59
Branchiobdellidae 57
Cambarincola 57, 58, 59, 60
 chirocephala 58
 macrodonta 59
 Cantilevers, bending 116
Chamberlainia cyrtophylla 127
Cirrodrilus 57, 58
 Cline, Justus Henry 139
 Colloids 1-6
 Committee Reports
 Collegiate Members 189
 Flora 192
 Finance and Endowment 183
 James River Project 190
 Journal 23, 199
 Local Arrangements 77, 157, 194
 Junior Academy 184
 Long Range Planning 181
 Membership 190
 Place of Meeting 194
 Research 23, 182
 Resolutions 193
 Resource-Use Education 191
 Science Talent Search 187, 195
 Science Teaching 195
 Speakers Bureau 193
Craspedacusta sowerbii 137
Dichelyma capillaceum 127
Ditrichum heteromalla 126
 heteromalla orthocarpa 126
Drepanocladus aduncus 127
 Elastic Equation 116
 Electrons 101
Elodea 111
 Ferromagnetic Deflection 101
 Financial Statement
 Academy 174
 Journal 181, 200
 Fluids, viscous 14-18
Fontinalis novae-angliae 127
Frullania Kunzei 125
Funaria flavicans 127
 Grant-in-Aid 24
 Harmonics 7-10
Helodium paludosum 127
Hemidactylium scutatum 65-66
Hesperocorixa
 interrupta 111-115
 nitida 111, 112
Histomonas meleagridis 71
 Institute for Scientific
 Research 198
 Iron Oxide 129
 Jellyfish, freshwater 137
 Jet Engines 43
 Ramjet 44
 Pulsejet 46
 Turbojet 47
 Jet Propulsion 41
 Level flight 41
 Definition 43
 Laboratory Tests, program 19-22
Leskea arenicola 127
Leucolejeunea conchifolia 125
 Lipotropic action 11-13
 Manuscripts, Suggestions for
 inside back cover
 Membership Application 325
 Membership List
 Senior 294
 Student 322
Mesodon 62, 63
 appressus 63
 rugeli 63
 Minutes
 Academy Conference 169
 Annual Meeting 202
 Council 141, 143, 168, 204
 Junior Academy 207

Junior Academy Meeting	207	Science Teachers	97, 283
Sections	209	Statistics	37, 69, 98, 151, 286
Multiphasic Screening	19, 22	Sheep, epidermis	71
Mu-mesons	101	<i>Sigara signata</i>	112
News and Notes	23, 67, 140	<i>modesta</i>	112
Officers and Committeemen	157	<i>alternata</i>	112
Oscillator, harmonic	7-10	<i>Sphagnum capillaceum</i>	125
Oxide pigments	129	<i>compactum</i>	125
<i>Palmocorixa buenoi</i>	111	<i>cuspidatum serrulatum</i>	125
<i>gillettei</i>	111	<i>cuspidatum torreyi</i>	125
<i>nana</i>	111	<i>cyclophyllum</i>	125
<i>Philonotis capillaris</i>	127	<i>henryense</i>	126
<i>Polytrichum commune perigoniale</i>	126	<i>imbricatum</i>	126
Presidents, List	156	<i>imbricatum affine</i>	126
President's Message	140	<i>magellanicum</i>	126
Proceedings, 1952-1953	155	<i>palustre</i>	126
Table of Contents	162	<i>recurvum</i>	126
<i>Pterodrilus</i>	57, 58, 59, 60	<i>strictum</i>	126
<i>alcicornis</i>	59	<i>subsecundum</i>	126
Rat	11-13	<i>tenerum</i>	126
<i>Rhytidium rugosum</i>	127	<i>Stenotrema</i>	62, 63, 64
Rocket Engine	51	<i>Stephanodrilus</i>	58
Salamander, egg-laying	65-66	<i>Thuidium Allenii</i>	127
Secretary Treasurer Report	171	<i>Tortula fragilis</i>	126
Sections		<i>Trichocorixa calva</i>	111
Agricultural	25, 81, 209*	<i>macroceps</i>	111
Astronomy, Mathematics and Physics	26, 82, 215	<i>Triodopsis</i>	62, 63, 64
Bacteriology	67, 71, 84, 225	<i>appressus</i>	63
Biology	27, 67, 71, 85, 228	<i>fraudulenta</i>	63, 64
Chemistry	28, 87, 145, 233	<i>tridentata edentilabris</i>	63
Education	35, 90, 244	<i>Vitamin B₁₂</i>	11-13
Engineering	91, 147, 250	<i>Viscous fluids</i>	14-18
Geology	92, 258	<i>Xironodrilus</i>	57, 58, 59, 60
Medical Sciences	95, 269	<i>pulcherrimus</i>	60
Psychology	37, 96, 151, 276	<i>Xironogiton</i>	57, 58, 59, 60
		<i>occidentalis</i>	60

* Italicized numbers indicate abstracts.

AUTHOR INDEX

Berko, Stephan	101	Goodwin, Ollie King	65
Bobb, Marvin	111	Hauser, Ernst A.	1
Burch, Paul Randolph	62	Heresford, Frank L.	101
Dechant, William G.	101	Hobbs, Horton H., Jr.	137
Dorsey, W. A.	19	Holt, Perry C.	57
Eisenberg, Phillip	116	Husted, Ladley	62
Forbes, J. C. F.	11	McShane, E. J.	7

Page, Charles H.	137	Whicker, L. Folger	116
Patterson, Paul M.	125	Williams, W. J.	19
Petterson, O.	11	Wood, John Thornton	65
Stow, Marcellus H.	139	Wright, Ralph R.	129
Szebehely, V. G.	14	Zucrow, M. J.	41

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C O N T E N T S

	Pages
The Science of Colloids — ERNST A. HAUSER	1
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THE VIRGINIA JOURNAL OF SCIENCE

VOL. 4, NEW SERIES

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No. 1

The Science of Colloids

ERNST A. HAUSER

Massachusetts Institute of Technology

Sir William Dampier Whetham made the following statement in 1932:

"To the scholar, the man of science sometimes seems to be busy about little facts and trivial problems in an entirely superficial way. On the other hand, to the philosopher or the man of science, if they ignore the underlying verities and look only to little interpretations, it seems that, as Hume said, 'Popular theology has a positive appetite for absurdity.' . . . Here again the historical method enables us to get beneath surface trivialities, see the deepest secrets of nature that may lie hid in the movement of the needle of a galvanometer or the marking on a butterfly's wing and trace the groping of man's soul . . . And so physical science continually widens our knowledge of the phenomena of the natural world and of the relations between the concepts, final or proximate, that we use to interpret the phenomena . . . As Newton said, 'The business of natural philosophy is to argue from phenomena . . . and to deduce causes from effects till we come to the very first cause, which certainly is not mechanical'."

Exactly twenty years before Sir Whetham made his statement, the German scientist, Wilhelm Ostwald, made the following remarks:

"Natural science and natural philosophy are not two fields which oppose each other, but they belong together just as two paths which lead to the same goal. This goal is: The mastery of nature by the human being. This is accomplished by the various natural sciences, all of which collate the actual circumstances between natural phenomena and attempt to discover if and to what extent they depend on each other. This is done in order to be able to predict one phenomenon from what is known of another with more or less accuracy. Natural philosophy joins in such attempts, but only in a more general way . . . Every representation of science has its natural philosophical component. In specific articles in which scientists report their progress, the natural philosophical components are generally present in the form of assumptions, of sentences which are not discussed, frequently not even referred to specifically, but on whose acceptance the most important deductions are based. In all such cases these important sentences can never be found in the right places. If they are contained in the introduction of the textbook they are of little value because the facts they actually should summarize are developed only later in the book. If they are contained in

Editor's Note: We are pleased to present this invited article by Mr. Ernst A. Hauser, Professor of Colloid Chemistry at the Massachusetts Institute of Technology, and Visiting Professor of Colloid Chemistry at the Worcester Polytechnic Institute in Worcester, Mass.

the summary at the end they are too late because they have been previously used already in many instances without, however, referring to their general importance. The best thing to do is to permit generalization only in such measure as the given individual facts call for and justify.

"Therefore any education in natural sciences is interpenetrated by natural philosophy. Just as one can obtain a survey over a complicated structure, as for example the confusion of streets in a large city, only if one has all information about the individual streets and also knows the relation of one to another after having studied a general city plan, it is advisable when studying a special branch of science to look at the general plan so that one does not become confused whenever one's path leads through an unfamiliar section."

Michael Faraday's life history is one of the most striking examples of Ostwald's and Whetham's reasoning. When Faraday reached the age of thirteen he had to start earning his own living. In 1805 he became an apprentice bookbinder, and although he did not have an opportunity to attend an advanced school, he loved to read the scientific books which he had to bind. Occasionally his superior gave him permission to attend some evening lectures on science, and in 1812 a customer of the shop who had heard of Faraday's interest in science gave him a ticket for a course of four lectures on chemistry offered by Humphry Davy. On March 1, 1813, Faraday entered the employment of the Royal Institution as Davy's assistant. Shortly thereafter Faraday accompanied Davy on an extended trip to Europe where he became acquainted with several leaders in the field of electrical problems. During the years 1831 to 1840 Faraday devoted most of his time to research in electro-magnetic problems. At the age of forty he laid the foundation for what we today term a transformer and for what we consider as a modern dynamo..

On February 5, 1857, Michael Faraday presented the Bakerian Lecture. He had chosen as his title, "Experimental Relations of Gold (and Other Metals) to Light." In this lecture he made the following statements:

"Agents competent to reduce gold from its solution are very numerous, and may be applied in many different ways, leaving it either in films, or in an excessively subdivided condition. Phosphorus is a very favourable agent when the latter object is in view. If a piece of this substance be placed under the surface of a moderately strong solution of chloride of gold, the reduced metal adheres to the phosphorus, as a granular crystalline crust. If the solution be weak and the phosphorus clean, part of the gold is reduced in exceedingly fine particles, which becoming diffused, produce a beautiful ruby fluid. . . .

"Fluids thus prepared may differ much in appearance. Those from the basins, or from the stronger solutions of gold, are often evidently turbid, looking brown or violet in different lights. Those prepared with weaker solutions and in bottles, are frequently more amethystine or ruby in colour and apparently clear. The latter, when in their finest state, often remain unchanged

for many months, and have all the appearance of solutions. But they never are such, containing in fact no dissolved, but only diffused gold. The particles are easily rendered evident, by gathering the rays of the sun (or a lamp) into a cone by a lens, and sending the part of the cone near the focus into the fluid: the cone becomes visible, and though the illuminated particles cannot be distinguished because of their minuteness, yet the light they reflect is golden in character, and seen to be abundant in proportion to the quantity of solid gold present. Portions of fluid so dilute as to show no trace of gold, by colour or appearance, can have the presence of the diffused solid particles rendered evident by the sun in this way."

Michael Faraday offered further evidence for his conclusion, but unfortunately his point of view was not accepted.

It cannot be denied that Faraday, on the basis of pure logical reasoning, made most important contributions to the science of colloids. It was Thomas Graham, however, who laid the scientific foundation of colloid chemistry. Graham published two particular papers, the first of which must be regarded as the actual cornerstone of systematic colloidal research. He paid no attention to the argument which started with Faraday's disclosure because he was primarily interested in studying the diffusive power of liquids and in establishing differences comparable to various degrees of volatility. The respective passage of Graham's paper reads as follows:

"The comparatively fixed class, as regards diffusion, is represented by a different order of chemical substances, marked out by the absence of the power to crystallize, which are slow in the extreme. Among the latter are hydrated silicic acid, hydrated alumina and other metallic peroxides of the aluminous class, when they exist in the soluble form; with starch, dextrin, and the gums, caramel, tannin, albumen, gelatin, vegetable and animal extractive matters. Low diffusibility is not the only property which the bodies last enumerated possess in common. They are distinguished by the gelatinous character of their hydrates. Although often largely soluble in water, they are held in solution by a most feeble force. They appear singularly inert in the capacity of the acids and bases, and in all the ordinary chemical relations. But, on the other hand, their peculiar physical aggregation with the chemical indifference referred to appears to be required in substances that can intervene in the organic processes of life. The plastic elements of the animal body are found in this class. As gelatine appears to be its type, it is proposed to designate substances of the class as 'colloids,' and to speak of their peculiar form of aggregation as the 'colloidal condition of matter.' Opposed to the colloidal is the crystalline condition. Substances affecting the latter form will be classed as 'crystalloids'."

Graham also pointed out that a dominating quality of colloids is the tendency of their particles to adhere, aggregate and contract. If it is

borne in mind that the colloidal state of matter is the result of a peculiar attraction and aggregation of molecules, it is not surprising that colloidal characteristics spread on both sides into the liquid and solid condition. Unfortunately, however, Graham did not continue his research and paid no attention to the possibility that gold sols might exist.

About thirty years after Graham had published his basic contribution a few scientists claimed that colloids are true solutions and that only a few insoluble particles are present. In contrast thereto, a few other scientists, particularly Wilhelm Ostwald, claimed that this statement was not correct but that one is actually dealing with matter in an extremely fine degree of dispersion. Richard Zsigmondy was one of those who originally had voiced serious objections to Faraday's statements. He claimed that the so-called "heterogeneous" theory of colloidal solutions was incorrect. Zsigmondy, however, decided to try to prove or disprove Faraday's hypothesis. He figured that if he could place a solution of colloidal gold sol on the microscope table and then focus the sunlight at a right angle onto the container in which he had placed the sol, he might be able to discover whether or not such particles actually existed. In the publication in which he discussed his experiment and in which he refuted the solution theory, he stated:

"How entirely erroneous was my idea! A swarm of dancing gnats in a sunbeam will give one an idea of the motion of the gold particles in the solution. This motion gives an indication of the continuous mixing up of the fluid, and it lasts hours, weeks, months, and if the fluid is stable, even years."

Immediately thereafter Zsigmondy contacted H. Siedentopf, who was the scientific adviser of the Carl Zeiss optical works in Jena, and they developed what still today is known as the "slit ultramicroscope."

Not only did this invention increase the range of visibility from about 500 millimicrons down to dimensions of only a few millimicrons, but it also established the following facts of general importance to natural science:

1. That colloidal solutions must be classified as heterogeneous systems insofar as their noncoherent particles, microscopically invisible but detectable in the ultramicroscope, are suspended in a medium. The size of these particles is below 10^{-4} cm. and above 10^{-7} cm.

2. That since the Brownian motion of the ultramicroscopically visible particles can be considered as a thermal movement following the same laws as deductible from the kinetic-gas theory, ultramicroscopy must be accepted as the first actual experimental proof that the kinetic-gas theory with all its conclusions stands to fact.

3. That experimental proof could be offered for the energy-distribution law of Boltzmann-Maxwell.

Fairly soon after the slit ultramicroscope had been developed special condensers were built which made it possible to use the standard type of microscope to determine the presence or absence of colloidal particles.

If the preparation under investigation is composed of nonspherical particles, however, it will be difficult to determine their actual shape. The slit ultramicroscope made this possible because the light enters the preparation only from the side. Nonspherical particles will therefore twinkle, in contrast to spherical particles which would show no change from the point of view of illumination.

Richard Zsigmondy deserves special credit not only for his invention of the slit ultramicroscope but also for having admitted to himself that his original idea was not based on facts.

The science of colloids depends to a great extent on information and experience gained from other fields of science than chemistry. For example, we owe most of our knowledge of the structure of matter to the X-ray diffraction technique. It therefore seems only fitting to explain what actually led Wilhelm Roentgen to make his great discovery.

In 1895 while working in Wurzburg, Roentgen noticed that a barium platinocyanide screen which happened to be lying close to a highly exhausted vacuum tube which was connected with the electric current exhibited pronounced fluorescence. Further investigation showed him that the radiation had the power of passing through various substances which are opaque to ordinary light. He also found that this radiation, which he later termed "X rays", would also cause the darkening of an unexposed photographic plate. For this discovery he received the Rumford Medal of the Royal Society in London in 1896. In 1901 Roentgen also received the Nobel Prize for Physics. His discovery very soon found its application in physics, particularly in evaluating the molecular structure of matter. We owe the most important contributions in this respect to von Laue, and shortly thereafter, to Debye and Scherrer.

One of the greatest contributions in the field of X-ray studies was in studying the structure of rubber. It could readily be shown that if unstretched rubber was subjected to X-ray diffraction, only a simple amorphous band was visible. Upon stretching, however, it became evident that the rubber showed a pronounced alignment in the direction of stretch. Soon thereafter it was ascertained that rubber which has been subjected to freezing would show unoriented zones of "crystalline" structure. It was also possible to prove that if rubber was subjected to very fast expansion, it no longer gave any indication of what was known as an amorphous band. On the basis of this work the so-called multi-phase theory of rubber has been worked out. This theory has demonstrated the function of the plastic phase in rubber. The "plasticizer" is the low molecular weight fraction. In its absence the rubber (natural or synthetic) loses most of its elastic properties.

The science of colloids has also made it possible to develop entirely new techniques for the production of rubber articles. We owe this development entirely to what we have learned about the colloidal condition of rubber latex. It should also not be overlooked that we owe our knowledge of how to produce synthetic rubber emulsions to what the science of colloids has taught us about the natural rubber milk sap.

Ore flotation is another field of applied colloid science. We deal here with ground ore containing nonmetallic ingredients. Depending on the affinity of the ore to certain chemicals which are added to the slurry, it is readily possible to separate the ore from the worthless matter.

In another field, systematic research has revealed that the enzyme hyaluronidase is quite active in the prevention of kidney stones. In the absence of a sufficient quantity of hyaluronidase, stone formation will be accelerated by the growth of crystals or by the agglomeration of the dispersed phase of inorganic colloids. This fact also offers excellent proof that many colloids owe their stability mainly to the electric charge they carry on their surface. Those colloids which are called "hydrophilic" owe their stability primarily to their affinity to water. They will therefore react quite differently from the so-called "hydrophobic," water-hating, colloids. All work carried out along these lines has demonstrated the need of most accurate studies of the electro-kinetic potential carried by colloidal matter.

One could continue almost indefinitely to offer further evidence of the importance of colloid science and why its history is so important. There is almost no modern industry which can afford to disregard the science of colloids. Just to mention a few, the following fields might be referred to: the soap industry; the production of natural and synthetic fibers; the natural and synthetic rubber industry; the entire field of antibiotics; the ceramic industry, where the condition of the clays depends primarily on their surface properties; the ink industry; the brewing of beer; and the colloid-chemical properties of all photographic processes.

Example after example could be offered to give a more detailed discussion of what colloid science actually stands for. It must not be overlooked, however, that it includes far more than just chemistry alone. A basic knowledge of physics, too, for example, is essential for really valuable contributions in these days. The modern colloid scientist needs a well-founded knowledge of both chemistry and physics.

Men working in other fields—in medicine, geology, biology, food technology and many other branches of science — also need at least a smattering of colloid science. Without this knowledge they cannot ascertain if, and to what extent, colloidal phenomena are involved in their problems and how they could be handled. The science of colloids is more far-reaching than most people realize, and from now on more cognizance should be taken of this undeniable fact.

The Spectrum of the Harmonic Oscillator

E. J. McSHANE
University of Virginia

In any text on quantum mechanics it is proved that with proper choice of units, the simple harmonic oscillator has eigenvalues $\frac{1}{2}, \frac{3}{2}, \frac{5}{2}, \dots$. This is usually done by means of solving a boundary value problem. But this implies using a special way of representing states and observables. Closer to the heart of the system are the simple algebraic relations between operators, in particular the commutation rules; even if the scheme of representing states must be complicated, for example to obtain relativistic invariance, the algebra will survive. P. A. M. Dirac showed, in his famous book [Principles of Quantum Mechanics, Oxford Press, 1947] that if we assume that the Hamiltonian operator for the oscillator has a pure point spectrum, it can be proved from the algebraic relations alone that the spectrum consists of $\frac{1}{2}, \frac{3}{2}, \dots$. In this note we prove from the algebraic relations that the spectrum must necessarily be a pure point spectrum, consisting of exactly the points just mentioned.

From the theory of quantum mechanics we choose a few central concepts. We start with a Hilbert space S ; usually this is taken to be the set of functions in the coordinate-space which have integrable squares, but to us this is at present irrelevant. The inner product in S is denoted by parentheses; thus (f,g) is the inner product of f and g , which in the usual interpretation would be the integral of the product of the function f with the conjugate of g . To each physical observable corresponds a self-adjoint operator on S ; to each state of a system corresponds a unit vector in S ; and when the system is in the state corresponding to the unit vector ψ , and the observable corresponding to operator B is observed, the expected value of the observable is the value of the inner product $(B\psi, \psi)$.

In a one-dimensional system consisting of an object elastically attracted to the origin, let p denote the momentum and q the coordinate of the object. If the units are properly chosen, the total energy is $(p^2 + q^2)/2$. Let P and Q be the self-adjoint operators corresponding to the respective observables p and q ; the Hamiltonian operator, corresponding to the total energy, is then

$$(1) \quad H = (P^2 + Q^2)/2.$$

We do not need to know the special form of operators P and Q . But we do need the facts that for every φ to which we can apply H we can also apply P , Q , PQ and QP , and that (with proper units) we then have

$$(2) \quad PQ\varphi - QP\varphi = -i\varphi.$$

Since P , Q , and H are self-adjoint, for each φ and ψ in the domain of H we have $(P\varphi, \psi) = (\varphi, P\psi)$, and so on. But since the inner product has the property $(i\varphi, \psi) = i(\varphi, \psi) = (\varphi, -i\psi)$, we also have

$$(3) \quad ([P + iQ]\varphi, \psi) = (\varphi, [P - iQ]\psi).$$

From (1) and (2) we readily compute that for all φ and ψ in the domain of H ,

$$(4) \quad [P - iQ][P + iQ]\varphi = [2H + 1]\varphi.$$

$$(5) \quad [P + iQ][P - iQ]\psi = [2H - 1]\psi.$$

In (5) we choose $\psi = [P + iQ]\varphi$; with the help of (4), (5) becomes

$$(6) \quad [P + iQ][2H + 1]\varphi = [2H - 1][P + iQ]\varphi.$$

Concerning the spectral resolution of H we need the following well-known facts.¹ To each real number u corresponds a projection operator E_u (in another, but not better, terminology $E_u\varphi$ would be the vector obtained by expanding φ in eigenfunctions and eigendifferentials of H and retaining only that part of the expansion corresponding to characteristic numbers $\leq u$) with the properties

(7) *E_u increases with u and is right continuous; as u tends to ∞ , E_u tends to 1, and as u tends to $-\infty$, E_u tends to 0.*

(8) *If $a \leq b$, then $E_a E_b = E_b E_a = E_a$.*

(9) $\int_{-\infty}^{\infty} d_u(E_u\varphi, \psi) = (\varphi, \psi)$ for all φ and ψ in S .

(10) *For all finite a and b , and all φ , $(E_b - E_a)\varphi$ is in the domain of H , and also in the domains of H^2 , H^3 , etc.*

(11) *For all φ in the domain of H and all ψ in S ,*

$$\int_{-\infty}^{\infty} u d_u(E_u\varphi, \psi) = (H\varphi, \psi).$$

Let φ be any vector, and let $\varphi' = (E_b - E_a)\varphi$. By (8), we have

$$\begin{aligned} E_u\varphi' &= E_u\varphi - E_a\varphi = 0 && \text{if } u \leq a, \\ &= E_u\varphi - E_a\varphi && \text{if } a < u \leq b, \\ &= E_b\varphi - E_a\varphi && \text{if } u > b. \end{aligned}$$

Hence if we replace φ by φ' in the integrals in (9) and (11), on the range of integration $-\infty < u \leq a$ the product $(E_u\varphi', \psi)$ is constant, so this contributes nothing to the integral, and likewise for $b < u < \infty$, so we have

$$(12) \quad \int_a^b d_u(E_u\varphi, \psi) = ([E_b - E_a]\varphi, \psi),$$

$$(13) \quad \int_a^b u d_u(E_u\varphi, \psi) = (H[E_b - E_a]\varphi, \psi).$$

If we replace a, b, u by c, d, v , reverse the order in each inner product (which changes it to its complex conjugate) and then interchange letters φ, ψ , these become

$$(14) \quad \int_c^d d_v(\varphi, E_v\psi) = (\varphi, [E_d - E_c]\psi),$$

¹See, for example, J. von Neuman *Mathematische Grundlagen der Quantenmechanik*, Dover Publications, 1943.

$$(15) \quad \int_c^d v d_v (\varphi, E_v \psi) = (\varphi, H [E_d - E_c] \psi).$$

Let φ, ψ be any vectors in S , and let $R: a < u \leq b, c < v \leq d$ be any rectangle in the plane. For brevity we write

$$(16) \quad f = (E_b - E_a)\varphi, \quad g = (E_d - E_c)\psi.$$

Then by (3), (10), (12), (13) and (14) we obtain

$$\begin{aligned} (17) \quad ([P + iQ][2H + 1]f, g) &= ([2H + 1]f, [P - iQ]g) \\ &= \int_a^b (2u + 1) d_u (E_u \varphi, [P - iQ]g) \\ &= \int_a^b (2u + 1) d_u ([P + iQ] E_u \varphi, g) \\ &= \int_a^b \int_c^d (2u + 1) d_u d_v ([P + iQ] E_u \varphi, E_v \psi). \end{aligned}$$

Similarly from (3), (10), (14), (15) and (12)

$$\begin{aligned} (18) \quad ([2H - 1][P + iQ]f, g) &= \int_c^d (2v - 1) d_v ([P + iQ]f, E_v \psi) \\ &= \int_c^d (2v - 1) d_v (f, [P - iQ] E_v \psi) \\ &= \int_a^b \int_c^d (2v - 1) d_u d_v (E_u \varphi, [P - iQ] E_v \psi). \end{aligned}$$

We again apply (3) to the last, and subtract (18) from (17) member by member; by (6) we obtain

$$(19) \quad 0 = 2 \int_a^b \int_c^d (u - v + 1) d_u d_v ([P + iQ] E_u \varphi, E_v \psi).$$

Now let us introduce a factor $f(u, v)$ under the integral sign in (19), producing a symbol

$$(20) \quad \int_a^b \int_c^d f(u, v) (u - v + 1) d_u d_v ([P + iQ] E_u \varphi, E_v \psi).$$

If f is a constant, this is 0 by (19). If f is a step-function, meaning that R can be cut into finitely many sub-rectangles on each of which f is constant, then by applying (19) to each small rectangle we find that the integral over each is 0, so when we combine them we find that (20) is still 0. If $f(u, v)$ is continuous in R and on its boundary, it can be uniformly approximated by a sequence of step-functions f_1, f_2, \dots . For each f_n the integral (20) (with f_n in place of f) vanishes, so the limit (20) also is 0. Now suppose that $u - v + 1$ does not vanish in R or on its boundary. Then we can choose $f(u, v) = 1/(u - v + 1)$, and (20) will still vanish. But now the integration is easy; we obtain

$$(21) \quad ([P + iQ][E_b - E_a]\varphi, [E_d - E_c]\psi) = 0$$

if the rectangle $a \leq u \leq b, c \leq v \leq d$ does not meet the line $u - v + 1 = 0$. By (3) this can be written

$$(\varphi, [E_b - E_a][P - iQ][E_d - E_c]\psi) = 0.$$

But φ is arbitrary, so

$$(22) \quad [E_b - E_a][P - iQ][E_d - E_c]\psi = 0$$

for a, b, c, d as described. By an easy limiting process we find that we can replace b by $+\infty$ or a by $-\infty$ provided that the set $a \leq u \leq b, c \leq v \leq d$ does not meet the line $u - v + 1 = 0$.

Now let λ be a point which belongs to the spectrum of H , while $\lambda - 1$ does not. We can choose a small interval $a \leq u \leq b$ centered about $\lambda - 1$ for which $E_b = E_a$, since $\lambda - 1$ is not in the spectrum. Let $c \leq v \leq d$ be a still smaller interval centered on λ . Since λ is in the spectrum, $E_d \neq E_c$, and there is a non-zero vector ψ in the range of the projection $E_d - E_c$. Then $[E_d - E_c]\psi = \psi$. Since neither the set $-\infty < u \leq a, c \leq v \leq d$ nor the set $b \leq u < \infty, c \leq v \leq d$ contains any point with $u - v + 1 = 0$, we have by (22)

$$[E_a - 0][P - iQ]\psi = 0,$$

$$[1 - E_b][P - iQ]\psi = 0,$$

and since $E_b = E_a$,

$$[E_b - E_a][P - iQ]\psi = 0.$$

Adding these three equations yields

$$[P - iQ]\psi = 0.$$

Hence $[P + iQ][P - iQ]\psi = 0$, or by (5) $[2H - 1]\psi = 0$. That is, $H\psi = \frac{1}{2}\psi$, and ψ is a characteristic vector belonging to the characteristic number $\frac{1}{2}$.

It is easy to see that the two facts: (a) ψ is in the range of $E_d - E_c$ and (b) ψ belongs to $\frac{1}{2}$ combine to prove that $\frac{1}{2}$ is in the interval $[c, d]$. But $[c, d]$ is an arbitrarily small interval centered on λ ; and if every such interval contains the point $\frac{1}{2}$, then λ must itself be $\frac{1}{2}$. Thus we have shown that if λ is in the spectrum and $\lambda - 1$ is not, then $\lambda = \frac{1}{2}$.

The spectrum contains a smallest number λ_0 . Then $\lambda_0 - 1$ is not in the spectrum; so $\lambda_0 = \frac{1}{2}$. Now for each λ such that $\frac{1}{2} < \lambda < \frac{3}{2}$, $\lambda - 1$ is not in the spectrum (being less than the least number $\frac{1}{2}$ in the spectrum), so λ cannot be in the spectrum, not being $\frac{1}{2}$. So there is no point of the spectrum between $\frac{1}{2}$ and $\frac{3}{2}$. In the same way there is none between $\frac{3}{2}$ and $\frac{5}{2}$, and so on. The only points which can possibly be in the spectrum are the points $(2n - 1)/2$, $n = 1, 2, 3, \dots$. Suppose one of these, say $(2m - 1)/2$, is not in the spectrum. Take this as $\lambda - 1$; if λ were in the spectrum it would have to be $\frac{1}{2}$, which it is not, so $(2m + 1)/2$ would also be lacking, and so on. That is, if any of the points $\frac{1}{2}, \frac{3}{2}, \frac{5}{2}, \dots$ is out of the spectrum so are all later ones. Then the spectrum of H would have a greatest value, and H would be bounded, which it is not; so we see that the spectrum of H consists of all the numbers $\frac{1}{2}, \frac{3}{2}, \frac{5}{2}, \dots$ and of no others.

Lipotropic Action of Vitamin B₁₂ In the White Rat¹

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Drill and McCormick (1949) found that subcutaneous administration of a vitamin B₁₂ concentrate to rats on a 16 per cent protein and 51 per cent lard diet exerted a considerable lipotropic effect. Gyorgy and Rose (1950) showed that if 0.5 microgram of vitamin B₁₂ were given daily by mouth to rats on a low-fat diet a significant lipotropic effect was obtained but they were unable to demonstrate any lipotropic effect when the diet was high in fat. Gyorgy, however, in a recent publication (1951) has reported that if the vitamin B₁₂ intake is high, namely 20 micrograms per day, a good lipotropic effect is obtained even though the animals are on a high fat diet. Lucas, Ridout, Patterson, and Best (1951) studied the interrelationship among choline, vitamin B₁₂, and folic acid by supplementing a hypolipotropic basal diet with each separately, at different levels, and in various combinations. They were unable to demonstrate any effect of vitamin B₁₂ on liver lipids under their experimental conditions. Hale and Schaefer (1951) on the other hand, found that vitamin B₁₂ plus folic acid exerted a marked lipotropic effect when they were both given along with a suboptimum amount of choline. Burns and McKibbin (1951) showed that vitamin B₁₂ exerted a definite lipotropic action in weanling puppies.

In view of the fact that there is diversity of opinion regarding the lipotropic action of vitamin B₁₂, it would seem worth while to publish some of the results which we have obtained on the lipotropic action of this member of the vitamin B complex. Our results clearly confirm the lipotropic effect of vitamin B₁₂ in the white rat.

Experimental procedure—Young albino rats of both sexes raised in our own colony were used in nearly all of the experimental work. The initial weight of the animals on the 5 per cent fat diets was nearly all between 40 and 50 grams. Those on the 40 per cent fat diet were started a little heavier, weighing between 60 and 70 grams, since very young rats do very poorly on such a high fat-low protein diet. At the conclusion of the experimental period, the animals were sacrificed and their livers analyzed separately for cholesterol and neutral fat by a previously described procedure (Outhouse and Forbes, 1940). Results are expressed as percentages of the fresh liver weight. Since there was no apparent difference in response between sexes, the results obtained on all animals in a particular group have been averaged without regard to sex in compiling the data shown in Table I.

The composition of the basal diet was as follows: vitamin-free casein 100 gm., Crisco 50 gm., sucrose 803 gm., Cellu flour 20 gm., and Wesson salt mixture 27 gm., plus the following vitamins in milligrams/kg. of diet: thiamine hydrochloride 4, riboflavin 8, niacin 14, pyridoxine hydrochloride 6, calcium pantothenate 14, Menadione 10, biotin 5 and folic acid 5. Each

¹ Presented at the Annual Meeting of the Virginia Academy of Science, May, 1952.

animal received in addition one drop of Oleum Percomorphum (Mead, Johnson and Co.) five times per week plus one drop of wheat germ oil reinforced with 60 mg. of alpha tocopherol per cubic centimeter once a week. Any increase in either the casein or Crisco was at the expense of an equal weight of sucrose. Other supplements were as shown in Table I.

TABLE I. Effect of Vitamin B₁₂ on the Neutral Fat and Cholesterol Content of the Liver of the Albino Rat.

Number of rats	Days on diet	Average gain in wt.	Liver			Remarks
			Neutral fat	Choles- terol	%	
6	20	0.5	17.2 ± 4.4*	.55 ± .06*	Basal diet (5% fat)	
8	20	1.3	7.8 ± 2.0	.44 ± .11	Same + 60 mcg. B ₁₂ /kg. of diet	
5	28	1.0	27.3 ± 7.4	.64 ± .11	Basal diet (5% fat)	
10	28	1.4	7.0 ± 3.0	.46 ± .12	Same + 60 mcg. B ₁₂ /kg. of diet	
10	28	1.4	8.9 ± 1.8	.51 ± .15	Basal diet + .025% choline and inositol	
10	28	1.5	3.8 ± 0.8	.40 ± .09	As above + 60 mcg. B ₁₂ /kg. of diet	
8	30	2.0	13.4 ± 3.4	.51 ± .17	Basal diet but 15% casein	
10	30	2.7	5.1 ± 2.7	.43 ± .19	Same + 60 mcg. B ₁₂ /kg. of diet	
10	34	1.8	4.8 ± 1.9	.33 ± .14	Basal diet but 15% casein + .025% choline and inositol	
9	34	2.2	3.4 ± 2.1	.28 ± .06	As above + 60 mcg. B ₁₂ /kg. of diet	
9	39	0.4	38.3 ± 3.3	.95 ± .14	Basal diet but 40% fat	
8	39	0.4	31.2 ± 4.3	.86 ± .12	As above + 60 mcg. B ₁₂ /kg. of diet	
18	27	0.7	17.5 ± 7.0	.55 ± .11	Basal diet but 40% fat	
18	27	0.6	16.3 ± 9.2	.48 ± .14	Same + .025% choline and inositol	
17	27	1.3	6.7 ± 3.6	.39 ± .15	As above + 60 mcg. B ₁₂ /kg. of diet	

* Standard deviation

It will be seen that vitamin B₁₂ in the concentrations used exerted a marked lipotropic effect in the absence of other lipotropic agents when the diet was relatively low in casein and fat. When the diet contained 10 per cent casein and 40 per cent fat, vitamin B₁₂ in the concentrations used

showed no definite lipotropic effect if choline and inositol were absent from the diet. When the diet contained .025 per cent of both of these substances, however, the lipotropic effect of vitamin B₁₂ became quite obvious. Gyorgy (1951), as already mentioned, has shown that if the vitamin B₁₂ intake is high, 20 micrograms per day, no additional lipotropic agents are necessary in order to demonstrate its lipotropic effect in rats on a high fat diet. It would appear that the difference noted in the lipotropic action of vitamin B₁₂ in animals on a low fat and high fat diet is probably altogether a result of the increased lipotropic requirement as the fat content of the diet is increased. Thus an amount of lipotropic activity sufficient to show a definite response in animals on a low fat diet would be wholly inadequate if the diet were high in fat.

Summary.—Addition of 60 micrograms of vitamin B₁₂ per kilogram of diet has been found to exert a distinct lipotropic effect in the young white rat when the diet contains only 5 per cent fat. This amount of vitamin B₁₂ exerted no definite lipotropic effect, if fed as the sole lipotropic agent, when incorporated in a diet containing 40 per cent fat. When the high fat diet contained .025 per cent choline and inositol respectively, however, the further addition of 60 micrograms of vitamin B₁₂ per kilogram of diet exerted a good lipotropic effect.

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COMPRESSIBLE VISCOUS FLUIDS^{1,2}

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Equations describing the flow of a compressible viscous fluid have been formulated by several authors.⁴ The equation of momentum includes two viscosity coefficients which are analogous to Lamé's constants of elasticity (Szebehely and Pletta, 1950). For monatomic gases, a relation exists between the viscosity coefficients. If this relation is introduced into Duhem's equation, the classical Navier-Stokes equation results. Illingworth (1950) reported the results of investigations of a few problems regarding compressible viscous flow of gases using the above mentioned special relation between the viscosity coefficients. In the present paper, no relation is assumed between viscosity coefficients; therefore, the following results are applicable to polyatomic gases and liquids. On the other hand, no thermal effects will be considered in this paper, and physical constants of the fluids investigated are assumed to be constant.

Since compressible fluids are investigated and no relation is assumed between the viscosity coefficients, the effect of the second coefficient of viscosity can be studied.

BASIC EQUATIONS FOR VISCOUS COMPRESSIBLE FLUIDS

Three unknowns are considered, the velocity vector \bar{v} , (with components u , v and w in a rectangular Cartesian coordinate system), the pressure p and the density ρ . Three equations are used to relate the above unknowns to the space coordinates (x , y , z) and to the time, t . The equations are the conservation of mass, or the so-called continuity equation, the Navier-Poisson-Duhem, or the so-called momentum equation, and the equation of state, which connects pressure and density.

The continuity equation is

$$\frac{\partial \rho}{\partial t} + \operatorname{div}(\bar{v}\rho) = 0 \quad (1)$$

or using Cartesian rectangular coordinates:

$$\frac{\partial \rho}{\partial t} + \frac{\partial(\rho u)}{\partial x} + \frac{\partial(\rho v)}{\partial y} + \frac{\partial(\rho w)}{\partial z} = 0 \quad (1a)$$

The Navier-Poisson-Duhem equation is obtained if the stress tensor is introduced into the equation of motion. The elements of the stress tensor are:

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³Presently: David Taylor Model Basin, Navy Department.

⁴See Duhem, 1901.

$$\left. \begin{aligned}
 p_{ii} &= -\delta_{ii}p + \delta_{ii}\lambda u_{k,k} + \mu(u_{i,i} + u_{j,j}) \quad \text{or} \\
 \sigma_x &= -p + \lambda \operatorname{div} \bar{v} + 2\mu \frac{\partial u}{\partial x} \\
 \sigma_y &= -p + \lambda \operatorname{div} \bar{v} + 2\mu \frac{\partial v}{\partial y} \\
 \sigma_z &= -p \equiv \lambda \operatorname{div} \bar{v} + 2\mu \frac{\partial w}{\partial z} \\
 \tau_{xy} &= \tau_{yx} = \mu \left(\frac{\partial u}{\partial y} + \frac{\partial v}{\partial x} \right) \\
 \tau_{yz} &= \tau_{zy} = \mu \left(\frac{\partial v}{\partial z} + \frac{\partial w}{\partial y} \right) \\
 \tau_{zx} &= \tau_{xz} = \mu \left(\frac{\partial w}{\partial x} + \frac{\partial u}{\partial z} \right)
 \end{aligned} \right\} \quad (2)$$

Making use of equations (2), the momentum equation is obtained:

$$\rho \left(\frac{\partial \bar{v}}{\partial t} - \bar{g} \right) = -\operatorname{grad} p - \rho \operatorname{grad} \frac{\bar{v}^2}{2} + \rho \bar{v} \times \operatorname{curl} \bar{v} \\
 + (\lambda + 2\mu) \operatorname{grad} \operatorname{div} \bar{v} - \mu \operatorname{curl} \operatorname{curl} \bar{v}. \quad (3)$$

Here \bar{g} is the external force vector per unit mass, μ is the first (ordinary) coefficient of viscosity and λ is the second coefficient of viscosity. The three coordinates of equation (3) using rectangular Cartesian coordinates are:

$$\left. \begin{aligned}
 \rho \left(\frac{\partial u}{\partial t} + u \frac{\partial u}{\partial x} + v \frac{\partial u}{\partial y} + w \frac{\partial u}{\partial z} \right) &= -\frac{\partial p}{\partial x} + \rho g_x + \mu \Delta u \\
 &+ (\lambda + \mu) \frac{\partial}{\partial x} \left(\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} \right)
 \end{aligned} \right\} \quad (3a)$$

$$\left. \begin{aligned}
 \rho \left(\frac{\partial v}{\partial t} + u \frac{\partial v}{\partial x} + v \frac{\partial v}{\partial y} + w \frac{\partial v}{\partial z} \right) &= -\frac{\partial p}{\partial y} + \rho g_y + \mu \Delta v \\
 &+ (\lambda + \mu) \frac{\partial}{\partial y} \left(\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} \right)
 \end{aligned} \right\} \quad (3b)$$

$$\left. \begin{aligned}
 \rho \left(\frac{\partial w}{\partial t} + u \frac{\partial w}{\partial x} + v \frac{\partial w}{\partial y} + w \frac{\partial w}{\partial z} \right) &= -\frac{\partial p}{\partial z} + \rho g_z + \mu \Delta w \\
 &+ (\lambda + \mu) \frac{\partial}{\partial z} \left(\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} \right)
 \end{aligned} \right\} \quad (3c)$$

The equation of state connects the pressure and the density $\rho = f(p)$.

In the conventional Navier-Stokes equation, the $\lambda = -\frac{2}{3}\mu$ relation is assumed. For incompressible fluids, the continuity equation gives

$$\operatorname{div} \bar{v} = 0,$$

and therefore, the second viscosity coefficient has no effect. (See equations (2), (3), (3a), (3b) and (3c).)

The average compressive stress can be defined as one third of the first invariant of the stress tensor (2):

$$p_m = -\frac{\sigma_x + \sigma_y + \sigma_z}{3},$$

where the minus sign is used because positive stresses are connected with tensile stresses. From equations (2)

$$p_m = p - (\lambda + \frac{2}{3}\mu) \operatorname{div} \bar{v}$$

or

$$p - p_m = (\lambda + \frac{2}{3}\mu) \operatorname{div} \bar{v} \quad (4)$$

Equation (4) gives $p = p_m$ for incompressible fluids, *i.e.*, the average compressive stress and the pressure are identical. This is also true if the $\lambda = -\frac{2}{3}\mu$ relation is assumed. Actual measurements showed that the $\kappa = \lambda + \frac{2}{3}\mu$, "volume viscosity" (as defined by Reiner, 1951) is not zero for liquids and that its value varies for different fluids (Truesdell, 1952).

SPECIAL CASE

It is interesting to show the effect of viscosity in a classical compressible flow problem. The basic equation of two dimensional gas dynamics is

$$\phi_{xx}(c^2 - \phi_x^2) + \phi_{yy}(c^2 - \phi_y^2) - 2\phi_x\phi_y\phi_{xy} = 0, \quad (5a)$$

where ϕ is the potential function ($\operatorname{grad} \phi = \bar{v}$) and c the velocity of sound. The derivation of this equation uses: (1) the Euler equation for steady flow of non-viscous fluids, neglecting body forces and assuming potential flow:

$$\rho \operatorname{grad} \frac{\bar{v}^2}{2} = -\operatorname{grad} p,$$

(2) the continuity equation for the steady flow of compressible fluids:

$$\operatorname{div}(\rho \bar{v}) = 0,$$

(3) The equation for the velocity of sound:

$$c = \sqrt{\frac{dp}{d\rho}}.$$

If the usual linearization is performed, equation (5a) becomes

$$\phi_{xx}(1 - M^2) + \phi_{yy} = 0, \quad (5b)$$

where $M = U/c$ is the free stream Mach number and U the free stream velocity. The linearization process assumes the velocity components in the form:

$$\frac{\partial \phi}{\partial x} = \phi_x = u = U + u' \quad \text{and} \quad \frac{\partial \phi}{\partial y} = \phi_y = v = v'$$

where u' and v' are "second order small" quantities.

In the subsonic case ($0 < M < 1$) with the

$$\xi = \frac{x}{\sqrt{1 - M^2}}, \quad \eta = y$$

substitution (5b) goes over to the Laplace equation:

$$\phi_{\xi\xi} + \phi_{\eta\eta} = 0 \quad (5c)$$

The basic equation for the steady flow of viscous, compressible fluids, neglecting body forces is obtained if (1) the special case of equation (3):

$$\rho \operatorname{grad} \frac{\bar{v}^2}{2} = -\operatorname{grad} p + (\lambda + 2\mu) \operatorname{grad} \operatorname{div} \bar{v}$$

(2) the continuity equation:

$$\operatorname{div}(\rho \bar{v}) = 0$$

(3) and the equation for the velocity of sound:

$$c = \sqrt{\frac{dp}{d\rho}}$$

are combined. Since $p = p(\rho)$, therefore $c = c(\rho)$ or $\rho = f(c)$.

The new basic equation is

$$\phi_{xx}(c^2 - \phi_x^2) + \phi_{yy}(c^2 - \phi_y^2) - 2\phi_{xy}\phi_x\phi_y$$

$$= -\frac{\lambda + 2\mu}{f(c)} (\phi_x \Delta \phi_x + \phi_y \Delta \phi_y) \quad (6a)$$

If viscosity is not considered, then the right side of equation (6a) disappears and equation (5a) is obtained.

Making the same linear assumptions as before, equation (6a) is

$$\phi_{xx}(1 - M^2) + \phi_{yy} = -\frac{\lambda + 2\mu}{cf(c)} M(\Delta \phi)_r \quad (6b)$$

Equation (6b) cannot be changed to the simple form of equation (5c), in fact equation (6b) is a third order partial differential equation. The third order terms represent the viscous effects.

SUMMARY

In the paper, the general form of the Navier-Poisson-Duhem equation was presented and applied for special flow problems regarding viscous compressible fluids. The basic equations become very much involved even when linearization is performed. The effect of the second coefficient of viscosity was studied. It was shown that if either viscosity or compressibility are neglected, the second viscosity coefficient disappears from the equations. Monatomic gases, due to the $\lambda = -\frac{2}{3}\mu$ relation, are not suitable for studying the effect of the second coefficient of viscosity. Water, however, very little compressible seems to be a better medium since its viscosity is more prominent than that of gases. The existence of potential flow of compressible viscous fluids was assumed in the paper.

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Experiences of the Multiphasic Screening Program from a Laboratory Standpoint in Richmond, Virginia

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"Screening," as used in this paper, is the application of presumptive laboratory tests and clinical procedures to an individual to detect suspicious evidence of a disease or abnormal condition. Definitive diagnostic procedures are instituted to establish whether or not the suspect becomes a case if evidence through screening so indicates. "Mass Screening" is the same technique applied to the population at large.

The objective of a mass screening program is to detect the presence of one or more asymptomatic diseases or conditions in individuals being screened. It is the outgrowth of the recognition by the medical and related professions of the necessity of approaching the ever increasing chronic disease problem with a combined community effort. The results of delayed diagnosis and treatment are a high mortality and morbidity rate in a community. The early detection of diseases, while they are still in the asymptomatic stage, means less needless suffering, less loss of life, and decreased medical expense.

In recent years, as laboratory science has progressed, the use of less specific tests of high sensitivity has become accepted practice in the selection of individuals for comprehensive medical examination. The value of this concept was not generally recognized until the impact of mass blood testing for syphilis and chest X ray for tuberculosis made such procedures widely acceptable. It is now well recognized that the application of clinically reliable examination techniques to the apparently well population is an accepted case finding procedure. Thus, mass screening, as it has become known in the popular sense, depends upon laboratory test procedures of high sensitivity which can be performed rapidly and economically. Effective screening procedures must be sufficiently selective to reveal presence of the condition being tested, and at the same time, be sufficiently accurate to eliminate false positives. The tests should be easy to perform, permit speed in collection of the samples, and should not cause undue inconvenience to the person being tested. If these prerequisites can be fulfilled various multiples can be added to suit the specific needs of a community.

The use of more than one test on any given group of the population is not new, although it is only within recent years that it has increased in popularity. The first linkage of tests came when in 1939 the tobacco industry of Richmond was surveyed for the combined detection of tuberculosis and syphilis. Later, in other areas more test procedures such as blood sugar for diabetes were added to this procedure.

In the spring of 1949, the Division of Chronic Diseases of the United States Public Health Service planned five mass population surveys for chronic diseases. Four of these were located in urban areas and one in a

rural area. The urban projects were Framingham, Massachusetts; Flattemouth, Indiana; Atlanta, Georgia; and Richmond, Virginia. The rural project was planned for selected counties in Alabama. The Richmond project was the first large scale mass screening program to get underway. Tests were conducted for the following conditions: syphilis, tuberculosis and other chest conditions, heart diseases, hypertension, anemia, diabetes, obesity, visual acuity, and intraocular tension. In addition, every tenth person was given an electrocardiogram with twelve leads as a part of a special study.

There is no set rule on what may or may not be included in the mass screening of population. The ones chosen for Richmond were selected because they seemed most pertinent to the locality. The consensus of all concerned with the planning of the multiphase program in Richmond was that only acceptable laboratory procedures should be used in the mass screening program. It was felt that while new procedures could be used to evaluate, they should be checked by standard procedures, and in case of variance, the latter results be used for reporting. Full approval for participation in the program was obtained from the Richmond Academy of Medicine, and every procedure used in the program was approved and accepted by an advisory committee of the Academy.

Although it was recognized that most of the examinations were performed at the screening clinic, urine examinations for diabetes and the blood serology for syphilis were performed more economically and with less effort at the main laboratory.

There was considerable insistence to do blood sugars rather than urine sugars. Despite this insistence it was decided to do urine sugars because there could be no control over meal time of the persons going through the clinic, and because the sugar threshold of urine is higher than that of blood. Consequently, blood sugars would result in too many false positive reactions. Since all positive results were to be rechecked at the individual's expense in private laboratories, too many positives due to over sensitivity, might lessen the effectiveness of the program. This has since been proven correct in the use of the Wilkerson and Heftmann test, as the levels of the reagents have been lowered to 160 and 180 mg. in order to reduce the sensitivity to normal limits.

In addition, the machine used in the Wilkerson and Heftmann test, and known by the nick-name, "Tillie, the Tin Technician," was not available at the time, and other methods were too slow and would require too much personnel.

In choosing a technique where large volumes of urine could be handled in an accurate manner by a small and not too technically trained personnel, the use of Clinitest tablets was picked as most suitable. It was found that one technician could handle, under pressure, 525 specimens per day, although the usual number was about 450. This included numbering the specimen and report slip, examining the specimen, and recording the result. All reactors were rechecked before reporting the results.

In a test conducted by the U. S. Public Health Service at our laboratories in May, 1950, in a comparison study of 1500 specimens of blood and urine, only twelve discrepancies were revealed. Daily capacity of both tests was about 400 to 450. To maintain a steady run of the machine, however, would necessitate one person to dilute the blood or sera, one person to run

the Wilkerson and Heftmann machine and read the results, and one person to wash the glassware.

Blood serologies were made by the Kahn procedures, using the Kahn presumptive test as a screen and rechecking all reactors with the three-tube Kahn standard test. No quantitative tests were performed on the screening specimens. Due to scarcity of trained public health laboratory workers, the increased work load was offset by the use of college graduates in doing non-technical work—such as numbering specimens, centrifuging, inactivating sera, and setting up the runs for the experienced workers to complete and read. These college graduates were untrained. As time permitted, they were trained to pipette and do other semi-technical work.

At the clinic, the Dare Hemoglobinometer was used because the sensitivity was high enough for screen testing, and it provided the fastest method of determination. At the blood table three graduate nurses took blood pressure readings and drew blood specimens while on volunteer, with previous experience in making hemoglobin tests, kept pace with all three. A special narrow cuff used to take the blood pressure served as a tourniquet for taking the blood specimens. The choice of the B-D vacutainer was an excellent one. Since no blood was spattered around the blood table and since the people were processed rapidly, the number of persons fainting at the sight of blood was held to a minimum. Of 15,000 persons examined during the first month, only two became sick, and neither of these fainted. The use of previously sterilized tubes made unnecessary the washing and sterilizing of syringes at the clinic site. The reuse of the 13x100 mm. size vacutainer tubes at the laboratory further offset the original cost.

During the multiple screening program, the City Laboratory acted as a service center for the clinic: preparing specimen containers for urinalysis; washing and sterilizing needles; supplying vacutainers, clean linen, office supplies, *et cetera*. The choice of urine containers presented somewhat of a problem. A single unit screw-cap aluminum container, similar to those used by insurance companies, were unavailable. Since tests for sugar alone were being made, and as the total amount of urine needed was only ten drops, the blood serology container was ideal. A small thymol preservative tablet in a sterile 13x100 mm. corked test tube was found to be adequate. Request slips were not used since a space for a serial number was provided on the mailing label.

Vacutainer needles were washed, dried, wrapped in cotton gauze, and sterilized eight to a petri dish. These were transported to the clinic and kept there in petri dish holders of thirty plates each. After use the needles were dropped in cold haemosol solution in gallon jars and returned to the laboratory for rewashing and sterilizing.

At the peak load the additional employees necessary to carry on work amounted to two semi-technically trained technicians in the serology laboratory, one technician for the urinalysis, two maids to help with the glassware washing and sterilizing of needles, and one additional person in the container room.

Results of the screening program in Richmond, which lasted from January, 1950, until August, 1950, were quite interesting and enlightening. Of the total of 37,609 persons who were examined in the clinic, 24,496 or

65% had no abnormalities; 13,113 or 35% were suspects for one or more diseases.

In a more definitive examination of the results of the individual examinations, the Kahn presumptive test for syphilis segregated 322 persons, or 0.8% of the group for further investigation. From past experience in this area, one would have expected 2% positivity. It should be considered, however, that in an overall study of the economic status of the persons tested, the majority were well above the median and were not in a group which would normally give a higher percentage of syphilis. This, coupled with the fact that the Kahn test is of lower sensitivity than some of the newer cardiolipin tests, resulted in a lower figure than expected.

Urine tests for diabetes gave 347 positive reactors and 170 doubtfuls from 35,010 persons tested, a percentage of 1.4%.

Considering 12.0 gms. percent as lower limit of normal, hemoglobin determinations gave 4,914 readings out of 37,081, or 13.2% as abnormal.

Blood pressures were taken on 37,177 persons, using 150/100 as high limits. There were 5,370 persons or 11.7% with an elevation of either the systolic or diastolic over these levels, and of these 1,667 had both systolic and diastolic readings higher than these levels.

Of the 30,434 chest x-rays taken which were read for total pathology, 1,290 were classified as abnormal as to findings pertaining to the lungs, and 1,561 to the heart. In the re-x-raying on 14x17 film of 1,155, 496 persons showed definite pathology due to tuberculosis, and 300 showed other abnormalities. In the group of cardiac suspects, 245 were re-x-rayed using larger film, but only 32 of these were ruled out as negative.

On the basis of 37,000 persons tested, the Richmond experience showed a cost of \$1.79 a person.

Space allotted for this paper does not permit a complete breakdown of results as to sex, age, color, and economic status, or the comprehensive results of follow-up examination by private physicians.

It is hoped that the experience of our laboratory in this pilot study may prove useful to anyone contemplating a similar program. Consideration should be given to the following points: first, do not try to carry too great a load at the expense of the normal routine work without adequate help, both in trained reserve personnel and in enough non-technical support to allow full use of your technical knowledge; second, be sure to have adequate service personnel to take care of washing, sterilizing and preparation of supplies for the clinic; and third, do not allow the clinic to take more specimens than the laboratory can handle.

News and Notes

(Editor's note: News contributions should be sent to the person whose name appears at the end of the appropriate section.)

NEWS FROM THE EDITOR-IN-CHIEF

The Council, at its meeting in Lexington on October 12, 1952, agreed that in the Proceedings for 1952-1953—to be published in the September, 1953, Virginia Journal of Science—(a) all abstracts are to be limited to 150 words, and (b) all reports are to contain no more than 400 words, with the exception of those reports in which publication of audits, as well as those reports containing names of persons receiving awards—these exceptions required by the Academy.

It is requested that those members of the Academy submitting abstracts keep this information in mind, and that each committee chairman prepare a summary of less than 400 words of his report for inclusion in the Journal.

THIRTY-FIRST ANNUAL MEETING OF THE VIRGINIA ACADEMY OF SCIENCE

The following committee chairman will serve in arranging for the 1953 meeting of the Academy which will be held at the Virginia Military Institute, Lexington, on May 6, 7, 8, and 9.

General Chairman	- - - - -	Col. S. M. Heflin
Housing	- - - - -	Lt. Col. George B. Ax
Registration and Information	- - - - -	Col. R. C. Weaver
Traffic and Parking	- - - - -	Maj. L. L. Nichols
Junior Academy Exhibits	- - - - -	Lt. Col. J. B. Newman
Meeting Rooms and Equipment	- - - - -	Col. I. G. Foster
Commercial Exhibits	- - - - -	Mr. D. R. Carpenter
Field Trips	- - - - -	Col. R. P. Carroll
Special Dinners and Luncheons	- - - - -	Col. R. P. Carroll
Signs and Maps	- - - - -	Maj. S. W. Dobyns
Parades	- - - - -	Maj. L. L. Nichols
Entertainment (Ladies)	- - - - -	Mrs. S. W. Anderson

RESEARCH COMMITTEE

Encouragement of research in Virginia has always been one of the chief objectives of the Academy. Research Grants-in-Aid, and also the annually available J. Shelton Horsley Research Award, are offered by the Academy to encourage and stimulate research work of its members. The attention of Academy members is called to the availability of both the Grants-in-Aid and the award. The Research Committee urges the interest and participation of members in both.

RESEARCH GRANTS-IN-AID

The income from the Academy's Endowment Fund is set aside each year to provide assistance to Academy members who submit to the Research Committee worthy research problems for which financial aid is needed. Research grants have varied in amount but during recent years have averaged approximately \$150.00 each.

The applicant is requested to outline his problem and list the items for which assistance is required. The names and addresses of three persons who know his qualifications for scientific research should be submitted with his request.

Grants will be made on the basis of (1) apparent merit of the research project, and (2) the need of the grant to aid in carrying out a project, or some portion of it. Worthy problems being investigated by younger members and by members on staffs of smaller schools — as well as investigations by older members and by those on staffs of larger institutions — will be given full consideration in the awarding of grants.

Since funds are now available, the committee urges that applications be mailed at an early date to W. S. Flory, Jr., Boyce, Virginia, so that they may be considered at its next meeting.

J. SHELTON HORSLEY RESEARCH AWARD

Members of the Academy and officers of the Sections are requested to give thought to the entering of papers for the 1953 Horsley Research Award. The only requirements for eligibility for the J. Shelton Horsley Research Award are that submitted papers shall (1) present original research (2) by Academy members (3) at the annual May meeting, and (4) that the paper deals either with unpublished data or be a published work — if publication was not prior to May of the previous year (which would be May 1952 in the present case.)

The Section Officers are again asked to serve as advisors to the Research Committee and to pass on to it papers which they deem prize-worthy, even though they are not formally submitted for the award. This procedure in 1950, 1951, and 1952 has had the fine cooperation of all sectional officers concerned and has resulted in a marked increase in the number of papers considered.

Papers to be submitted in competition for the J. Shelton Horsley Research Award should be prepared in duplicate and sent to the Secretary of the Section concerned. The deadline date for getting such papers to the Secretaries will probably be April 1, 1953. Definite announcement of this date will be sent out by the Sectional Secretaries.

The 1953 J. Shelton Horsley Research Award will consist of (1) a Certificate from the Academy engraved with the name of the winner and signed by the current officers of the organization; and (2) a check in the amount of one hundred (\$100.00) dollars.

The Horsley Award is one of the top prizes available to scientists in Virginia. The widespread interest and participation of members in the seeking of this award will mark a healthy condition with respect to the type of research work being carried out in the State. Such interest and participation is desired and solicited.—W. S. FLORY, JR., *The Blandy Experimental Farm, University of Virginia, Boyce, Virginia.*

SECTION NEWS

AGRICULTURAL SCIENCE SECTION

Dr. R. W. Engel has been appointed Head of the Department of Biochemistry and Nutrition at the Virginia Polytechnic Institute. Dr. Engel is a native of Wisconsin. He received a Ph. D. degree in zoology and medical science from the University of Wisconsin in 1937 and a Ph. D. degree in biochemistry and nutrition from the same institution in 1939. Dr. Engel has served as Associate Professor and Professor of Animal Nutrition at the Alabama Polytechnic Institute since 1939 with the exception of two years spent in military service in the Pacific Theatre during World War II.

Under the direction of Dr. Engel the reorganized Department of Biochemistry and Nutrition at V. P. I. will be responsible for conducting investigations in cooperation with the Animal Husbandry, Dairy Husbandry, Poultry Husbandry, Home Economics, Horticulture, Agronomy, and Biology Departments. He and his staff will do much needed research on livestock, poultry, and human nutrition.

Several members of the Department of Horticulture attended the annual meeting of the American Society for Horticultural Science which was held at Cornell University in connection with the A. I. B. S. meeting in September. Dr. Wesley P. Judkins was elected to the Executive Committee of the A. S. H. S. The following papers were presented by members of the Department of Horticulture at the Cornell meeting: (1) Pine Mouse Control Based on Trail Concentrations, by Frank Horsfall, Jr.; (2) A New Subjective Judging Method as Applied to Horticultural Produce, by George E. Mattus; and (3) Viability of Fruit Pollens as Shown in Tests Employing 2, 3, 5-Triphenyl Tetrazolium Chloride, by G. D. Oberle and Richard Watson.

Several changes have taken place in the staff of the Animal Husbandry Department at V. P. I. Mr. Frank McClaugherty has moved from the Front Royal Beef Cattle Research Station to V. P. I. Jock Taylor has moved from the Holland Experiment Station to the Front Royal Station. Horace Thomas has returned to the Holland Experiment Station from his leave of absence, during which he was studying for his M. S. degree. Dr. R. L. Arthaud of Missouri has been appointed Assistant Professor in the Animal Husbandry Department effective September 1, 1952, and is located at the Front Royal Beef Cattle Research Station.

Several members of the Animal Husbandry Department at V. P. I. attended the annual meeting of the American Society of Animal Production which was held in Chicago. The following papers were presented: (1) Heritability of Rate of Gain from Progeny Tests with Beef Cattle, by C. M. Kincaid, R. C. Carter, and J. S. Copenhagen; and (2) Live Animal Scores and Split Carcass Measurements as Indicators of Carcass Value in Swine, by R. L. Arthaud and G. E. Dickerson (Missouri).

Professor C. W. Holdaway retired as Head of the Dairy Department, V. P. I., on October 1, 1952, with over 40 years' service to the dairy industry. Upon his retirement, Dr. G. C. Graf assumed the duties and responsibilities of the Head of the Dairy Department. Dr. Graf received his B. S. from Michigan State College and M. S. and Ph. D. from the University of Minnesota.

M. F. Elmore of College Park, Maryland, assumed his duties in the Agricultural Extension Service as Associate Extension Dairyman in charge of the dairy herd improvement, management, and feeding project on November 1, 1952. Professor Elmore is a native of Maryland and received his B. S. and M. S. degrees from the University of Maryland. He has completed a major portion of the requirements for his Ph. D. degree.

J. H. Lillard and T. W. Edminster of the Department of Agricultural Engineering, V. P. I., attended a meeting of West Virginia Section, American Society of Agricultural Engineers at Jackson's Mill, West Virginia, on November 7 and 8 and presented papers on the Theory and Design of Supplemental Irrigation Systems and Water Law Problems Related to Irrigation.

V. H. Baker and B. F. Parker of the Department of Agricultural Engineering at V. P. I. are at Michigan State College studying for the Ph. D. degree.

B. L. Parsons, Korean War Veteran, formerly of the Agricultural Engineering Department's teaching staff, returned to his old job in September.

R. L. Givens, U. S. D. A. Agricultural Engineer, is being transferred from the University of Georgia to the Tidewater Experiment Station at Holland, Virginia, where he will continue working on grain storage problems.

S. H. Byrne, Associate Professor in charge of teaching in the V. P. I. Agricultural Engineering Department, returned in September from Iowa State College where he has been studying for his Doctor's degree.

Paul W. Stoneburner, recently resigned as research associate in Agricultural Engineering, Virginia Agricultural Experiment Station, to become sales engineer for Atlantic Aluminum Company.

Denver D. Bragg of the Poultry Department, V. P. I., presented a paper entitled "An Attempt to Determine the Cause of Curled or Deformed Tongues in Young Beltsville White Turkeys" before the 41st annual meeting of the Poultry Science Association at Storrs, Connecticut, in August. Bragg is presenting this work as a thesis in partial fulfillment of the requirements for an M. S. degree. A twenty-eight page illustrated 4-H Poultry and Egg Judging bulletin by Denver D. Bragg was received from the printer in September.—WESLEY P. JUDKINS, *Virginia Polytechnic Institute*.

ASTRONOMY, MATHEMATICS, PHYSICS SECTION

Warren G. Roome, Chairman, Department of Mathematics at Radford College, is on leave studying at Columbia University.

Professor F. D. Rollins, Department of Mathematics, V. P. I., is doing graduate work at Vanderbilt University this year. Mr. V. Ray Hancock has been appointed instructor in the Mathematics Department at V. P. I.

Mr. Jacob L. Rhodes has been appointed Associate Professor of Physics and Acting Head of the Department of Physics and Engineering at Roanoke. He is completing his work for the Ph. D. from the University of Pennsylvania.

Dr. Marguerite Risley, Associate Professor of Mathematics and Astronomy at R. M. W. C., has been awarded a Ford Foundation Fellowship. She is on leave at this time studying at Harvard University. Mr. George S. Mumford III, who holds degrees from Harvard and the University of Indiana, is taking her place.

Mr. C. O. Alley, Jr., former member of the Physics Department at the University of Richmond, has returned to Princeton University to complete his graduate work. He has been replaced by Mr. Arthur E. Williamson, who is a graduate of Alabama Polytechnic Institute and comes to Richmond from North American Aircraft Co.

Harry L. Reaves has joined the faculty of Hampden-Sydney College, as Assistant Professor of Mathematics. He was formerly on the faculty of Clemson College.

Professor G. T. Whyburn, Chairman of the Department of Mathematics at the University of Virginia, is on leave this year. He holds a Faculty Fellowship under the Fund for the Advancement of Education.

Dr. Nicholas Cabrera of the University of Madrid is Visiting Associate Professor of Physics at Rouss Physical Laboratory of the University of Virginia. Dr. Cabrera is a former student of Brillovin and DeBroglie at the University of Paris and of N. F. Mott at the University of Bristol. He is working with Dr. Allen Gwathmey, President-Elect of the Virginia Academy of Science.

Dr. Harold L. Alden, Director of Leander McCormick Observatory of the University of Virginia, was a delegate at the Eighth General Assembly of the International Astronomical Union at Rome. Dr. Alden was elected president of the Commission on Stellar Parallaxes and Proper Motions. In this position he follows in the footsteps of Dr. S. A. Mitchell, Director Emeritus of McCormick Observatory.

The Physics Department at Virginia Military Institute has moved into its new quarters in Mallory Hall. Construction on the new physics laboratory of University of Virginia has been started.—I. G. FOSTER, *Virginia Military Institute*.

BIOLOGY SECTION

Mr. Lee Douglas is a new member of the faculty of Emory and Henry College as Assistant Professor of Biology. Mr. Douglas will be awarded the degree of Doctor of Philosophy by the University of Southern California in June, 1953.

Emory and Henry College has enrolled its first class of candidates for the Bachelor of Science degree in Nursing. The students receive part of their training at The Johnson Memorial Hospital in Abingdon which is affiliated with Emory and Henry College in offering nursing training.

Mr. Julien Cagle is a new member of the Department of Biology at Hollins College. Mr. Cagle received the degree of Master of Arts from the University of Tennessee and was formerly a member of the staff of Cumberland College in Kentucky.

Mr. Paul M. Patterson of Hollins College has been elected to the Governing Board of the American Institute of Biological Sciences. Mr. Patterson represents the American Bryological Society.

Mr. Jack D. Burke is now a member of the biology staff at Longwood College. Mr. Burke was awarded the Doctor of Philosophy degree by the University of Florida. His principle research is in physiology with especial interest in blood volumes.

Madison College announces that construction of its new science building is well underway and is scheduled for completion by the fall of 1953. The four-story building will house the departments of biology, chem-

istry, physics, geology, and geography. Future plans include wings which will make space available for the department of mathematics.

Miss Peggy Woodson, Instructor in Biology at Randolph-Macon Woman's College, has been granted leave of absence for the current academic year to continue work toward the doctorate. Miss Woodson has been awarded a research fellowship at McGill University to investigate problems dealing with the histology of pulmonary tissues.

Mr. Warwick R. West who received the degree of Doctor of Philosophy from the University of Virginia in June, 1952, and who formerly taught at Lynchburg College, has joined the faculty of the University of Richmond as Assistant Professor of Biology. Mr. West will offer courses in Entomology, Comparative Anatomy, and Embryology.

President Francis P. Gaines of Washington and Lee University recently announced the promotion of Mr. James Holt Starling from Associate Professor to Professor of Biology. Mr. John M. Herr from the University of Virginia has been appointed Instructor in Biology at Washington and Lee.

Mr. George K. Reid, Jr., of the University of Florida has been appointed Assistant Professor of Biology at the College of William and Mary. His chief interest is in animal ecology.

Mr. I. T. Quinn, executive director of the Virginia Game Commission, called together representatives of State and Federal land use agencies to discuss resource-use education in the state. As a result of this conference, a temporary advisory council on conservation education was established with Mr. J. J. Shomon, chairman; Mr. P. H. DeHart, vice-chairman; and Mr. R. R. Bowers, secretary. This temporary council will lead to a permanent organization to educate the public in conservation practices.

The Virginia Fisheries Laboratory, Gloucester Point, Virginia, is presenting a series of television programs to acquaint the public with problems of marine conservation.—ROBERT T. BRUMFIELD, *Longwood College*.

CHEMISTRY SECTION

Dr. Harry J. Kiefer has resigned his position as Head of the Chemistry Department at Hampden-Sydney College and has joined the research staff of the Glidden Company in Cleveland, Ohio. Dr. T. H. Pearson, formerly Assistant Professor of Chemistry at the Virginia Military Institute, has taken over Dr. Kiefer's duties at Hampden-Sydney.

Harriett H. Fillinger, Hollins College, published in August a laboratory manual of temporary instructions entitled "Chromatographic Analysis for the Metal Ions of a First Course in Qualitative Analysis". Funds to publish the manual and to provide for its distribution to a number of colleges and universities to check the analytical methods were made available through a grant from the Hollins College Research Fund. Miss Fillinger also published (with Lois Ann Trafton) a paper on the "Chromatographic Analysis of Metal Ions" in the June, 1952, issue of the *J. Chem. Educ.* and presented a paper on the same topic at the September meeting of the American Chemical Society in Atlantic City.

Dr. Elizabeth H. Burkey, Hollins College, was elected Secretary of the Virginia Blue Ridge Section of the American Chemical Society, and

H. H. Fillinger, who was Chairman of the Blue Ridge Section last year, is a new member of the Executive Committee (Council) of the Section this year.

Two graduates of Hollins College, Jean Marshall ('50) and Suzanne Peter ('51) hold positions as editorial assistants at the national headquarters of the American Chemical Society in Washington, D. C., and Lois Ann Trafton ('50) is a research assistant in the Department of Pharmacology at the University of Virginia. Miss Patricia Lewis Paynter ('51) is employed as a microanalyst in the Chemistry Department of the University of Virginia, and Miss Jane Kelly ('51) is working with Rodney C. Berry, State Chemist, in Richmond.

Dr. R. D. Cool, Professor of Chemistry at Madison College, attended the summer conference of the New England Association of Chemistry Teachers held at the University of Vermont in August. Also present at the meeting was Miss Caroline R. Gambrill of Fairfax Hall Junior College, Waynesboro.

Members of the 1952 graduating class at Madison College who have accepted positions in chemistry include: Mary Ellen Orr, Janet Lee Shelor, and Bette Jane Viar, now with du Pont at Martinsville; Charlotte Celia Korn with Dr. J. C. Forbes at the Medical College of Virginia; and Lawrence E. Paxton who has accepted a U. S. Civil Service appointment. Marianna Virginia Howard and Barbara Ann Groseclose, both former Madison students, are among the new chemistry teachers in the State. Miss Howard is located in Danville and Miss Groseclose in Wythe County.

Recent publications from the Medical College of Virginia: "Studies On The Effects of Metallic Salts on Acid Production of Saliva. I.", J. C. Forbes and J. D. Smith, *Journal of Dental Research*, 31, 129 (1952). "Metabolic Studies in Pernicious Anemia. I. Nitrogen and Phosphorus Metabolism During Vitamin B₁₂-Induced Remission" G. Watson James, III and Lynn D. Abbott, Jr., *Metabolism*, 1, 259 (1952).

Dr. J. C. Forbes, Professor of Research Biochemistry, and Mrs. Geraldine M. Duncan, Research Assistant, Medical College of Virginia, presented a paper on the "Effect of Alcohol Intoxication on the Cholesterol and Ascorbic Acid Content of Guinea Pig Adrenal Glands" at the April meeting of the American Society of Biological Chemists in New York City.

Dr. Lynn D. Abbott, Associate Professor of Biochemistry, Medical College of Virginia, was among a group of 42 research workers throughout the country who enrolled in an advanced course in radioisotope techniques offered in November by the Oak Ridge Institute of Nuclear Studies. Dr. Abbott is conducting investigations concerned with mechanisms influencing blood formation and destruction.

Publications by staff members of Randolph-Macon Woman's College include the following articles: "Acylation Studies. I. Methyl Cyclopropyl Ketone", George W. Cannon and Helen L. Whidden (R-MWC), *Journal of Organic Chemistry*, 17 (1952); "The Solubilities of Benzene, Nitrobenzene, and Ethylene Chloride in Aqueous Salt Solutions", J. H. Saylor, A. I. Whitten, Imogene Claiborne (R-MWC), and P. M. Gross, *Journal of the American Chemical Society*, 74, 1778 (1952); and "Dissociation Constants of Adrenergic Amines", Esther B. Leffer (R-MWC), Hugh M. Spencer, and Alfred Burger, *ibid.*, 73, 2611 (1951).

Miss Katherine Wright, Professor at American College, Istanbul, Turkey since 1931, has joined the staff at Sweet Briar College.

Dr. Dorothy D. Thompson has returned to Sweet Briar from sabbatical leave at the Institute of Textile Technology in Charlottesville. The results of her research at ITT, carried out with Jack Compton, C. P. Jones, and D. R. Roberts, were reported by Dr. Compton at the Southeastern meeting of the American Chemical Society held at Auburn, Alabama in October. The paper was entitled, "The Effect of Partial Cyanoethylation and Acetylation on Certain Measurable Properties of Cotton Fiber".

Miss Anne Pitts and Miss Jane Maxwell, both of Sweet Briar College, are continuing studies for their doctorate degrees, the former at Duke and the latter at Emory University.

W. Allan Powell has been appointed Assistant Professor of Analytical Chemistry at the University of Richmond, replacing Roger Buck, who is now associated with the Virginia Institute for Scientific Research. Mr. Powell has completed work for his doctorate at Duke University and plans to receive his degree in June.

Publications from the University of Richmond: "2-Methyl-2-monoalkylaminopropyl Aromatic Heterocyclic Carboxylates", J. Stanton Pierce and Henry A. Rutter, Jr., *Journal of the American Chemical Society*, 74, 3954 (1952); and "N-Aryl-N'-alkyloxamides for the Identification of Primary Alkyl Amines", A. G. Richardson, J. Stanton Pierce, and E. Emmet Reid, *ibid.*, 74, 4011 (1952).

The Research Corporation has awarded a grant to the University of Richmond to support an investigation of coordination complexes. The project will be under the direction of Dr. W. E. Trout and Dr. J. Stanton Pierce.

Dr. Thomas C. Franklin, Assistant Professor of Physical Chemistry at the University of Richmond, has also been awarded a grant from the Research Corporation to conduct polarographic studies of oxidation at the platinum electrode. He will be assisted in the work by R. D. Sothern.

Professor Raymond N. Castle of the University of New Mexico is spending a sabbatical leave of one year at the University of Virginia working with Dr. Alfred Burger on an American Tobacco Company post-doctoral fellowship.

Recent promotions of the chemistry faculty at the University of Virginia include Dr. Alfred Burger, Professor, Dr. Allan T. Gwathmey, Associate Professor, and Dr. Paul M. Gross, Assistant Professor. Mr. Carl D. Lunsford has received a one-year appointment as Instructor for teaching and research.

Dr. Nicholas Cabrera, formerly of the Bureau International des Poids et Mesures in Paris, is now an Acting Associate Professor of Physics at the University of Virginia. Part of his time will be devoted to research on the surface properties of metal crystals, studies being carried out in the Chemistry Department supported by the Office of Naval Research and directed by Dr. Allan T. Gwathmey.

Also on post-doctoral Office of Naval Research Fellowships are Dr. Fred W. Young and Dr. Kenneth R. Lawless, both recent graduates of the University, the former after a year at the Oak Ridge National Laboratory and the latter after a year in Norway on a Fulbright Fellowship.

Additional fellowship awards in chemistry at the University of Virginia are as follows:

Mr. Colin L. Browne has been awarded a fellowship by the National Science Foundation for research on ring-chain tautomerism under the direction of Dr. Robert E. Lutz.

Mr. Robert Darby is the recipient of a U. S. Public Health Service Fellowship for work on analogs of thyroxine under the direction of Dr. Alfred Burger.

Dr. R. E. Lutz has received a two-year grant from the Eli Lilly Company to support the research of Mr. Claibourne E. Griffin on compounds of possible medicinal value.

Mr. Edwin D. Hornbaker has been appointed Parke, Davis and Company Fellow. He will investigate potential tuberculous drugs.

The Virginia-Carolina Chemical Corporation is sponsoring two pre-doctoral fellowships under the direction of Dr. Alfred Burger. The Fellows, Miss Beverly E. Smith and Mr. Thomas Hilton, are working on organic compounds of phosphorus which are of biological interest.

Additional fellowships awarded to the Chemistry Department for pre-doctoral education include: The Merck Company Fellowship, held by Mr. Richard M. Rush; the du Pont Company Post-graduate Fellowship in Chemistry, held by Mr. Peter B. Sherry; and the Texas Company Fellowship held by Mr. James B. Wagner.

Dr. Allan T. Gwathmey of the University of Virginia staff received the Southern Chemists Award from the Memphis Section of the American Chemical Society for his work in the study of metal catalysis and for his leadership in the establishment of the Virginia Institute for Scientific Research. The award is given "for distinguished service to the profession of chemistry in the southern states" and was presented at the Southeastern Regional Meeting of the Society held in October at Auburn, Alabama.

Dr. John H. Yoe, Professor of Chemistry and Director of the Pratt Trace Analysis Laboratory, attended the International Congress on Analytical Chemistry at Oxford, September 4-9, 1952, and meetings of the International Committee on Analytical Reactions, also at Oxford, September 3 and 10. While in Europe, he visited the Macaulay Institute for Soil Research at Aberdeen, Scotland and the University of St. Andrews, Scotland.

Dr. Russell J. Rowlett, Dr. D. Scott Sears, and Earl B. Whipple joined the Virginia-Carolina Chemical Corporation Research Department as of July 1, 1952. Dr. Rowlett comes from Chemical Abstracts as patent coordinator; Dr. Sears from Goodrich Rubber as inorganic group leader; and Mr. Whipple as an organic chemist from graduate work at Harvard University.

Mrs. Frances Cook, formerly research physicist for General Mills at Minneapolis, has joined the staff of the Virginia Institute for Scientific Research.

Dr. Thomas C. Franklin and Mr. George P. Williams, both members of the University of Richmond Faculty, are serving as part-time staff members of the Virginia Institute for Scientific Research. Ballard Pierce, an undergraduate at the University of Richmond, is also assisting with studies using the electron microscope.

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Staff notes from the Virginia Military Institute: Assistant Professor B. W. Mundy has been promoted to Associate Professor of Physical Chemistry. Assistant Professor G. Wise has returned from service in the Navy, and Assistant Professor G. M. Pickral has returned from leave, granted for the purpose of pursuing graduate studies.

Dr. C. W. Smart of the V. M. I. staff has a publication (with H. R. Henze and W. J. Clegy) in the October issue of the *Journal of Organic Chemistry* entitled "Certain Derivatives of 2-Methyl Pyrimidine".

Another entire floor of Richardson Hall at the Virginia Military Institute has been converted to the use of the Chemistry Department. Two new laboratories devoted to qualitative and quantitative analysis have been completed and are now being used. A special invitation is extended to all V.A.S. members to inspect the facilities of the chemistry department at the annual meeting in May. All classrooms and laboratories will be open.

Dr. R. E. Hussey, Professor of Organic Chemistry, and a member of the staff at Virginia Polytechnic Institute since 1926, retired July 1, 1952.

Mr. W. B. Howsmon, Jr., a graduate of Berea College and Purdue University, has joined the staff at V.P.I. as an Instructor in Chemistry.

V. P. I. publications: "The Synthesis and Cyclization of Some *o*-Benzyl-phenones", F. A. Vingiello, J. G. Van Oot, and H. H. Hannabas, *Journal of the American Chemical Society*, 74, 4546 (1952); "A Study of the Shape Factor for High Polymers", by P. C. Scherer and J. E. Johnson, to appear shortly in *Modern Textiles*.

Dr. F. A. Vingiello, Associate Professor of Chemistry at V. P. I., has been awarded a contract by the Office of Ordnance Research for work on the synthesis of hydrocarbons. Two research assistants are working with Dr. Vingiello on the problem. Work on the project began October 1.

Dr. J. W. Watson, Head of the Chemistry Department at Virginia Polytechnic Institute and Councilor for the Virginia Blue Ridge Section of the American Chemical Society, attended the September meeting of the Society held in Atlantic City. As an invited guest, Dr. Watson also attended in September the dedication of Proctor and Gamble's new research laboratories located near Cincinnati, Ohio.

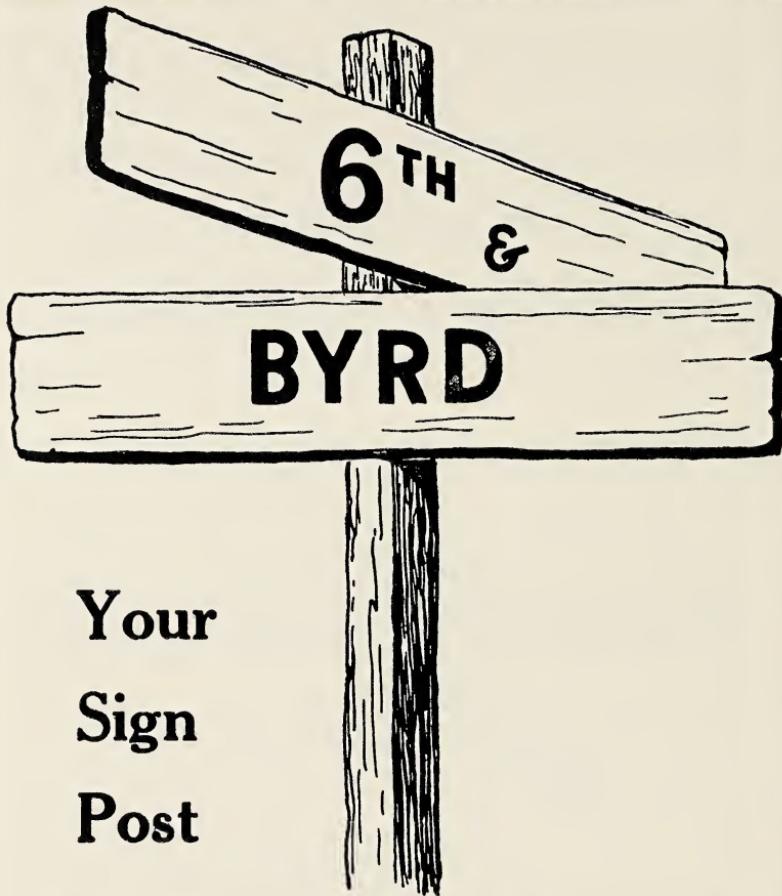
Dr. Frank A. Vingiello was a research participant during the summer at the Oak Ridge National Laboratory. With O. L. Neville he worked on the mechanism of the benzil-benzilic acid rearrangement using radioactive C¹⁴ as a tracer.

Dr. Robert C. Krug, also of the V. P. I. staff, was affiliated with the Virginia Institute for Scientific Research during July and August as a research chemist investigating some of the factors which are believed to influence the growth of large single crystals of certain metals.

Dr. E. F. Furtsch and Professor E. V. Russell worked during the summer on a research problem with the V. P. I. Engineering Experiment Station.

Dr. John F. Baxter has resigned as Professor of Chemistry at Washington and Lee University and is now located at the University of Florida.

Dr. E. S. Gilreath has been promoted from Assistant to Associate Professor at W. and L., and Dr. Elmer S. McKee has been added to the staff as an Assistant Professor of Chemistry.



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McGraw-Hill has announced the publication (in November) of a second edition of Dr. Lucius J. Desha's well-known text on "Organic Chemistry". Among the major changes in the new edition are the introduction of the concept of resonance and the electronic explanation of reaction mechanisms.

C. H. Rayburn will present a paper entitled "Determination of Some Volatile Phenols in Cigarette Smoke" at the Annual Tobacco Chemists Research Conference, which this year will be held at the University of Louisville, Louisville, Kentucky, December 4 and 5. J. M. Moseley, also of the research staff of The American Tobacco Company, will participate in a panel on "Analytical Methods."—CARL J. LIKES, *Virginia Institute for Scientific Research*.

EDUCATION SECTION

Preliminary Findings of the Committee On Science Teaching in Virginia Schools

A Committee on Science Teaching in Virginia Schools was created by the Academy late in 1951. The Committee consists of:

Dr. F. G. Lankford, Jr., (Chairman), Department of Education, University of Virginia

Dr. Byron M. Cooper, Department of Geology, Virginia Polytechnic Institute

Mr. John B. Chase, Jr., Department of Education, University of Virginia

Dr. George Jeffers, Head of the Department of Biology, Longwood College

Dr. James W. Cole, Department of Chemistry, University of Virginia

Dr. Percy H. Warren, Madison College

Dr. William M. Hinton, Professor of Psychology, Washington and Lee University

Mr. F. D. Kizer, Science Faculty of Norview High School

Dr. R. O. Nelson, Superintendent of Schools, Newport News, Virginia

Mr. Paul H. Cale, Superintendent of Schools, Albemarle County, Charlottesville

Currently the Committee has under way three studies.

One of these is being done by Professor Percy Warren and deals with science offerings in Virginia high schools, teacher assignments, and teacher preparation.

Among the preliminary findings are these:

"It was found that more than 50 per cent of the high schools in Virginia have a minimum science offering of general science, biology, and chemistry. Notwithstanding this fact, more than 50 per cent of the teachers who taught one or more classes in science taught only one or two science classes. More than 60 per cent taught only one science subject and more than 85 per cent of the teachers taught no more than two different subjects in science."

Professor Warren's data on preparation of teachers is now being tabulated. Mr. John B. Chase is studying for the committee the certification of science teachers. He is studying practices in Virginia as well as other states. He has also asked Virginia superintendents several questions regarding their practices and opinions. From this latter source he reaches the tentative conclusion (1) that superintendents feel that their high school science positions call for teachers who are certified to teach general science in combination with biology, with chemistry, or with physics, and (2) that superintendents feel that science teachers should have background in all phases of science and should be certified to teach more than one science.

Also, his preliminary findings indicate that there are 22 states with certification requirements in science comparable to, or higher than, those now existing in Virginia.

A third study from which the Committee may draw useful information is the Masters thesis completed by Mr. Philip Peterson at the University of Virginia. He studied science offerings and elections in Virginia high schools. Among his several findings this one on elections will be of great interest to the Committee. The most frequent combination of science elections by pupils in Virginia high schools is one unit in general science and one unit in biology (36%). The second most frequent combination of elections is one course in general science with one in biology and one in chemistry (19%). Only 6% of the high school pupils elect all four sciences including general science, biology, chemistry ,and physics.

—F. G. LANKFORD, *University of Virginia.*

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PSYCHOLOGY SECTION

An unusually large number of Virginia psychologists took advantage of the nearby convention of the American Psychological Association in September by attending the meetings in Washington. Dr. Gilbert J. Rich is the Chairman of the Committee on Scientific and Professional Ethics of the A. P. A. Mr. Frank A. Geldard, retiring President of the Division of Military Psychology, was appointed to the Education and Training Board of the A. P. A. Mr. William M. Hinton represented the Psychology Section at the conference of State Psychological Associations which was held during the A. P. A. meetings.

Mr. John N. Buck has resigned from the Examining Board for the Certification of Clinical Psychologists, having been succeeded in the chairmanship of that board by Mr. Hinton. Dr. Gilbert R. Rich is the new member of this board.

Mr. Henry A. Imus has completed a year's service as Scientific Liaison Officer in the field of Psychology, London Branch of the Office of Naval Research, and has returned to his duties as Head of the Physiological Psychology Branch, Psychological Sciences Division, Office of Naval Research in Washington. While he was in England, Mr. Imus was elected a fellow in the Royal Society of Medicine, a member of the Ergonomics Research Society, a member of the British Psychological Society, and a visiting foreign member of the Experimental Psychology group.

Mr. Jason Z. Edelstein has joined the Department of Psychology of the Eastern State Hospital as assistant psychologist. Mr. Edelstein received his M. A. degree from the University of New Hampshire and took his psychological internship at Danvers State Hospital, Massachusetts. The psychology department at Eastern State Hospital now consists of three psychologists, headed by Mr. David Orr as senior psychologist. The third staff member is Mrs. Elizabeth Williams, assistant psychologist. Mr. Orr is also a part-time lecturer in psychology at the College of William and Mary.

Miss Hannah Davis has been appointed chief psychologist to succeed Mr. John N. Buck at the Lynchburg State Colony.

Mr. John F. Hahn has assumed his duties as Acting Assistant Professor of Psychology at the University of Virginia. Mr. Hahn received his doctoral training at the University of Chicago, having done some of his graduate work with Professor L. L. Thurstone and having worked under the immediate direction of Professor Dewey Neff. Mr. Hahn succeeds Mr. Willard R. Thurlow, who took a position at the University of Wisconsin in February, 1952.

Mr. Frank W. Finger was a visiting member of the summer school staff at the University of Wisconsin. Visiting professors on the University of Virginia summer school staff were Mr. William M. Hinton, Mr. Robert C. Wingfield of Converse College, and Mr. John F. Hall of Pennsylvania State College.—RICHARD H. HENNEMAN, *University of Virginia*.

STATISTICS SECTION

M. E. Terry, formerly of the Department of Statistics and Statistical Laboratory, Virginia Polytechnic Institute, has joined the staff of the Bell Telephone Laboratories at Murray Hill, New Jersey. Dr. Terry served for

three years as secretary of the Statistics Section, and his departure is a great loss to the Academy and to the State.

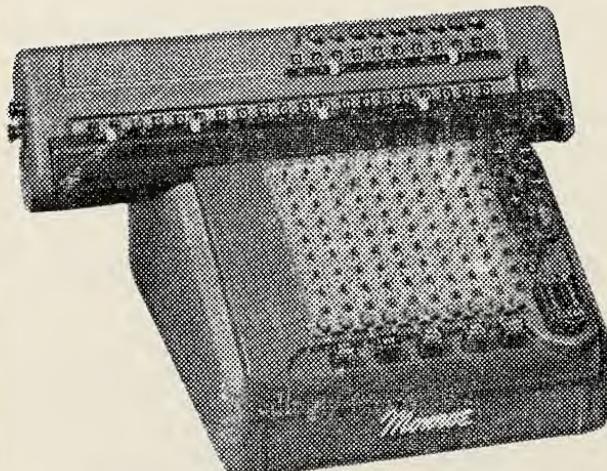
M. C. K. Tweedie, a graduate of University of Reading, England, and recently of Oxford, has joined the staff of the Department of Statistics and Statistical Laboratory of the Virginia Polytechnic Institute. His publications include "Inverse Statistical Variates," "The Regression of the Sample Variance on the Sample Mean," and "Functions of a Variate with Given Means, with Special Reference to Laplacian Distributions."

Lionel Weiss, formerly of the University of Virginia, has now joined the staff at Cornell University.

W. J. Youden, National Bureau of Standards, presented a paper on "Linked Blocks" at the session on Experimental Design at the Joint session of the American Statistical Association and Biometrics Society meeting in Chicago in December.

W. J. Youden and Churchill Eisenhart, both of the National Bureau of Standards, presented a paper on "Comparison of Standard Meter Bars" at the session on Application of Statistics to Physics at the meetings of the American Statistical Association in December.

D. B. Duncan and H. C. Sweeny of the Virginia Polytechnic Institute were invited to present papers at the session on applications of statistics in engineering at the meeting of the American Statistical Association in December. Dr. Duncan spoke on "Testing Homogeneity of Treatments in an Analysis of Variance of Engineering Data." Mr. Sweeny's title was "Some Applications of Statistics to Time and Motion Research." Boyd Harshbarger of the Department of Statistics and Statistical Laboratory, Virginia Polytechnic Institute, served as chairman of this session.



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M. E. Terry, now of the Bell Telephone Laboratories, presented a paper on "Rank Analysis in the Estimation of Threshold Values" at the session on Applications of Non-Parametric Methods at the Chicago meetings of the A. S. A. and Biometric Society.

At the joint meetings of the American Statistical Association and the Institute of Mathematical Statistics held in Chicago in December, M. C. K. Tweedie presented two papers. These are entitled "Bias in Estimation by Interval" and "The Covariances of Frequencies from a Multinomial Distribution under a Sequential Sampling Rule." R. A. Bradley of the Department of Statistics and Statistical Laboratory, Virginia Polytechnic Institute, presented an invited paper on "Non-Parametric Methods in the Elementary Statistics Course."

"New Designs and Techniques of Organoleptic Testing" by M. E. Terry, R. A. Bradley and L. L. Davis was published in the July issue of *Food Technology*. "The Rank Analysis of Incomplete Block Designs I — The Method of Paired Comparisons" by R. A. Bradley and M. E. Terry was published in the December issue of *Biometrika*.

The contract between the Department of Statistics and Statistical Laboratory, Virginia Polytechnic Institute, and the Bureau of Agricultural Economics for studies in subjective testing has been renewed for an additional two years. The research on this project has been under the direction of R. A. Bradley. Recently a contract for the computation of tables for the rank analysis of incomplete block designs has been awarded to the Department of Statistics by the Quartermaster Corps, U. S. Army. D. B. Duncan is chief investigator of a research contract on "Statistical Inference Problems Concerning Differences Between Ranked Treatments in an Analysis of Variance" recently awarded to the Department of Statistics by the Ordnance Corps. Work has been completed on a computational contract between the American Meat Institute Foundation and Department of Statistics and Statistical Laboratory. C. Y. Kramer has directed the computations on this project.

Twenty-four graduate students registered this fall for masters and doctors degrees in Statistics at the Virginia Polytechnic Institute. Among these are six who hold fellowships. Ronald E. Schneider and Patricia Ann Ripley hold fellowships with the National Institute of Health. Thomas S. Russell and Paul G. Sanders hold teaching fellowships. William Beyer, Richard G. Cornell, and Daniel Zakich hold research fellowships with the Virginia Agricultural Experiment Station.

Richard P. Bartlett has joined the staff of the United States Department of Agriculture as Statistical Agent at Raleigh, North Carolina.

R. A. Bradley presented an invited paper on "Statistical Methods in Taste Testing and Quality Evaluation" to the Joint Symposium of the Biometric Society and the American Society of Horticultural Science at Cornell University. He also presented a series of lectures on subjective testing to staff members of the Bureau of Agricultural Economics in Washington, D. C. and at Beltsville, Maryland.

Those desiring to present papers at the May meetings of the Academy should present abstracts to the Secretary of the Statistics Section at the earliest possible date.—C. Y. KRAMER, *Virginia Polytechnic Institute*.



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NOTICE TO CONTRIBUTORS

Contributions to the Journal should be addressed to Horton H. Hobbs, Jr., Miller School of Biology, University of Virginia, Charlottesville, Virginia. If any preliminary notes have been published on the subject which is submitted to the editors, a statement to that effect must accompany the manuscript.

Manuscripts must be submitted in triplicate, typewritten in double spacing on standard 8½" x 11" paper, with at least a one inch margin on all sides. Manuscripts are limited to seven pages, with the proviso that if additional pages are desired, the author may obtain them at cost.

Division of the manuscript into subheadings must follow a consistent plan, and be held to a minimum. It is desirable that a brief summary be included in all manuscripts.

Footnotes should be included in the body of the manuscript immediately following the reference, and set off by a dashed-line above and below the footnote content. Footnotes should be numbered consecutively from the beginning to the end of the manuscript.

Bibliographies (Literature Cited, References, etc.) should be arranged alphabetically according to author. Each reference should include the date, full title of the article, the name of the Journal, the volume, number (optional), pages, tables and figures (if any). For example: "Sniffen, Ernest W. 1940. Cobbles from the Pleistocene Terraces of the Lower York-James Peninsula, Va. Journ. Sci., 1 (8): 285-288, 1 fig. 1 tab. Reference to the bibliographic citations should not be made by numbers. Instead, using the above citations, where a reference is desired; either "Sniffen (1940)", "Sniffen, 1940: 186)", or "Sniffen (1940) states that . . .".

Explanations of figures, Graphs, etc., should be typed on separate pages. All figures should be numbered consecutively beginning with the first text figure and continuing through the plates. If figures are to be inserted in the text this should be clearly indicated by writing "Figure —" at the appropriate place in the margin.

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C O N T E N T S

	Pages
Fundamental Characteristics of Jet Propulsion Engines — M. J. ZUCROW	41
Characters of Systematic Importance in the Family Branchiobdellidae (Oligochaeta) — PERRY C. HOLT	57
The Chromosomes of the Polygyrid Snail, <i>Allogona profunda</i> — LADLEY HUSTED and PAUL RANDOLPH BURCH	62
Note on Egg-laying of the Four-toed Salamander, <i>Hemidactylum</i> <i>scutatum</i> (Schlegel), in Eastern Virginia — OLLIE KING GOODWIN and JOHN THORNTON WOOD	65
News and Notes	69
Program of the Thirty-first Annual Meeting of the Virginia Academy of Science	76

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No. 2

Fundamental Characteristics Of Jet Propulsion Engines

M. J. ZUCROW

Purdue University

From the day when the Wright Brothers flew at Kitty Hawk in 1902 until World War II, the reciprocating internal combustion engine, or piston engine, driving a propeller was the only propulsion system available to the aircraft designer. During the elapsed period of more than 50 years, the piston engine-propeller system was developed to a remarkable degree of reliability for so complicated a mechanism. The specific weight of the engine was lowered to approximately 1.1 pounds of dry weight per rated horsepower, and its fuel consumption reduced to approximately 0.5 pound per horsepower-hour. Despite these excellent accomplishments, the piston engine is not destined to play any significant role in the propulsion of aircraft flying at speeds above 450 miles per hour.

The objects of this paper are:

- (1) to point out why the piston-engine propeller system is inadequate for the propulsion of high speed aircraft; and
- (2) to discuss the fundamental characteristics of jet propulsion engines.

Power Required for Level Flight.—The horsepower which must be imparted to an airplane to maintain it in level, unaccelerated, flight is called the *thrust horsepower* P_T , and is given by:

$$P_T = \frac{FV}{375} = \frac{DV}{375} = \frac{\sigma V^3 C_D S}{146,000} \quad (1)$$

where

$$\sigma = \frac{\rho}{\rho_0} = \text{density ratio}$$

ρ_0 = density of atmospheric air at sea level = 0.002378 slug/ft.³

ρ = density of the atmosphere at altitude, slug/ft.³

V = true air speed, miles per hour.

C_D = drag coefficient = 391 $D/\rho V^2 S$

D = drag of airplane, lb.

S = projected wing area, sq. ft.

F = thrust, lb.

Editor's Note: We are pleased to present this invited article by M. J. Zucrow, Professor of Gas Turbines and Jet Propulsion, Purdue University, Lafayette, Ind.

Jet propulsion engines may, therefore, be grouped into two broad classes:

- (a) thermal jet engines, and
- (b) rocket engines.

Classification of Thermal Jet Engines.—Thermal jet engines may be segregated into the following three principal types (Zucrow, 1948):

- (a) the Ramjet Engine or Athodyd (Aero-Thermo-Dynamic-Duct);
- (b) the Pulsejet Engine; and
- (c) the Turbojet Engine.

Combinations of the principal types of thermal jet engines are possible and also their combinations with the rocket engine. The discussion will here be confined to the principal types of engines.

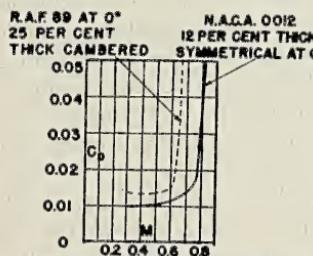
The Ramjet Engine—Figure 2 illustrates the essential features of the ramjet engine. It comprises a diffuser section; a combustion chamber section; and an exhaust nozzle section. The function of the diffuser is to decelerate the air entering the engine and to give an efficient transformation of its kinetic energy into a pressure rise, called the *ram* pressure. The ram pressure rise obtained will be a function of the flight speed, the inlet and diffuser design, and the area ratio of the diffuser.

In operation, the air compressed in the diffuser flows into the combustion chamber, which contains the fuel burners, and is heated to a high temperature by the continuous combustion of fuel. Although liquid fuels are most generally used, the Germans conducted limited experiments with solid fuels. The highly heated gases produced in the combustion chamber are then expanded in the exhaust nozzle and finally ejected to the atmosphere with a velocity exceedingly that of the entering air. Because of the increase in the momentum flux entering and leaving the ramjet engine, a reaction force or thrust is developed in the direction of flight. It is fairly evident that the performance of the ramjet engine will be affected by its flight speed.

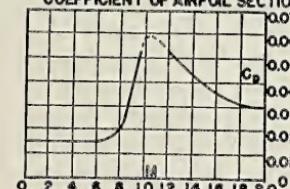
Since the operation and performance of the ramjet depends upon "building up" the ram pressure of the entering air, the engine cannot function at zero flight speed. To make it operative, the body propelled by the ramjet engine must be given an initial velocity by some auxiliary means. Because it is an "air-burning" engine, the maximum operating altitude of the ramjet is limited. The ramjet is inherently a device which performs best at very high speeds, and is potentially a power plant for attaining supersonic flight speeds. The origin of the ramjet is credited to the Frenchman, Lorin, 1913.

The propulsion characteristics of the ramjet engine indicate that it has excellent potentialities as a propulsion engine for achieving supersonic flight, especially for propelling certain types of supersonic guided missiles. Since combustion considerations necessitate reducing the free stream supersonic air velocities ($M > 1$) to a relatively low subsonic value ($M = 0.2$) at the entrance to the combustion chamber, the deceleration of the free

stream air at the inlet to the engine is accompanied by the formation of shock waves at the inlet, with the result that the entropy of the fluid entering the engine is increased above its free stream value, and energy losses, which can be serious, are introduced. Studies of the characteristics



EFFECT OF MACH NUMBER ON DRAG COEFFICIENT OF AIRFOIL SECTIONS



ESTIMATED DRAG COEFFICIENT VS MACH NO FOR AIRCRAFT OF THE GLOSTER METEOR TYPE

FIG. 1

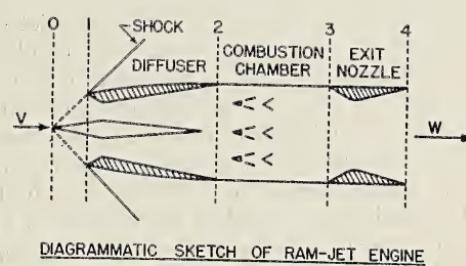
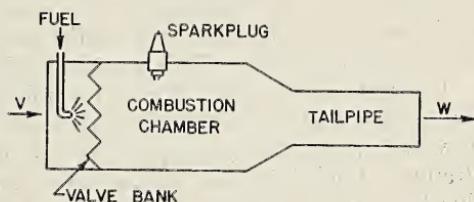


FIG. 2



PULSEJET ENGINE

FIG. 3

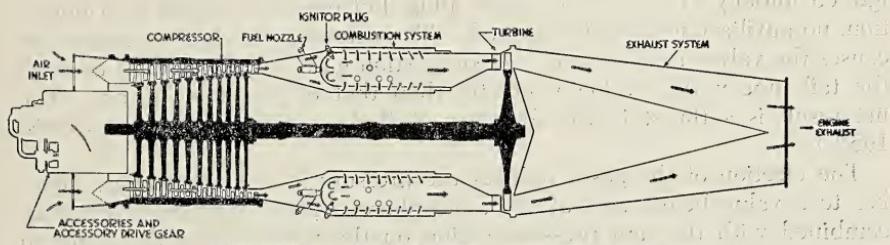


FIG. 4

Fig. 1—Effect of Mach Number on Drag Coefficient of Airfoil Section. Estimated Drag Coefficient vs. Mach No. for Aircraft of the Gloster Meteor Type.

Fig. 2.—Diagrammatic Sketch of Ram-Jet Engine.

Fig. 3.—Pulsejet Engine.

Fig. 4.—Schematic Flow Diagram of General Electric TG 180 Engine.

of air flow through a ramjet engine without combustion, conducted by the National Advisory Committee for Aeronautics, indicate that by appropriate design, the energy losses attendant to decelerating a supersonic stream of air to subsonic velocities can be minimized so that the actual ram pressure recovery will be a significant fraction of that theoretically available.

Considerable research effort must be expended to obtain information on basic phenomena occurring in ramjet engines. For example, one major problem is that of securing stable combustion in a velocity air stream at low absolute pressure, and the effect of combustion pulsations upon the shock waves formed at the entrance to the engine. Experiments have demonstrated that the interaction between the combustion pulsations and the shock waves at the engine entrance can cause the actual performance of a ramjet engine to fall considerably below that possible theoretically. The combustion problem is aggravated at high altitudes, due to the low absolute pressures in the combustion chamber. Considerable research in the field of subatmospheric burning at high air velocities is needed to provide information for extending the operating altitude of the ramjet engine. Other problems are aerodynamic in character and the background for solving them requires an extension of the scope of our present knowledge.

The Pulsejet Engine.—This engine is illustrated schematically in Figure 3. It comprises an inlet diffuser, a combustion chamber, and a valve bank through which air can flow in the direction of the tail pipe. When closed, the valves prevent any reverse flow of gases from the tail pipe to the entrance. Fuel injection nozzles are generally placed upstream to the valve bank, and an electric spark plug is located in the combustion chamber. The valves operate as shutters that open against their own spring pressure (Edelman, 1946; Morris, 1952.)

In flight, combustion air is forced into the engine by the ram pressure, and the fuel is supplied continuously. The resulting fuel-air mixture is ignited initially by the electric spark plug, but once the engine is in operation, no auxiliary ignition is required. The pressure rise due to combustion causes the valves to close, and the combustion gases are discharged through the tail pipe with a velocity greater than that of the entering air. The net result is a thrust in the direction of flight. (Edelman, 1946; Morris, 1952.)

The ejection of the gases reduces the pressure in the combustion chamber to a value below that of the atmosphere. The reduction in pressure combined with the ram pressure acting on the valves cause the latter to reopen, and a new cycle commences.

The pressure in the combustion chamber varies in a cyclic manner, the operating cycle repeating itself with a frequency that depends upon the physical dimensions of the unit. In the case of the German V-1 missile, commonly called the buzz-bomb, the firings occurred at an approximate rate of 40 per second. Pulsejet engines of smaller size, with 250 to 300 firings per second, have been built.

From an overall point of view, the pulsejet engine may be regarded as being an intermittent firing ramjet engine, and the thrust it develops

is proportional to the average values of the mass rate of flow of air times its increase in velocity. In the ideal case, the combustion process would be isovolumic, but in the actual case, because of the finite combustion time and the escape of gases through the tailpipe, the combustion process deviates considerably from the isovolumic process.

Like the ramjet engine, the thrust of the pulsejet engine increases with the flight speed, and its maximum operating altitude is limited by air density considerations. Unlike the ramjet, however, it develops thrust at zero speed, but a high initial launching velocity improves its performance.

Currently, there is no exact theory of operation for the pulsejet engine and that has probably hampered its development. It is generally believed, however, that aerodynamic conditions at the inlet limit its maximum flight speed to less than 600 miles per hour. The flight speed of the ramjet engine, on the other hand, appears to be limited by the aerodynamic heating effects of the outer skin, to speeds of the order of 2000 miles per hour. The pulsejet is a simple, cheap engine for subsonic flight and is well adapted to subsonic pilotless aircraft such as the German V-1 missile.

The first use of the pulsejet principle is credited to Karavodine of France (1906). The modern conception of the pulsejet engine is, however, due to the German, Paul Schmidt, who began his development of this engine in 1928 (Edelman, 1946).

The Turbojet Engine (The Gas Turbine Jet Engine).—This engine is currently the most important type of jet propulsion engine for aircraft propulsion. Figure 4 illustrates schematically the principal features of an axial flow turbojet engine, which is essentially a continuous combustion gas turbine. The air entering the engine is partially compressed in the diffuser and then compressed to a much higher pressure by either a centrifugal or an axial flow air compressor. The highly compressed air is then heated by the combustion of fuel in a combustion chamber to a temperature of 1500° to 1600° F.; the maximum allowable temperature is limited by metallurgical and stress considerations. The combustion takes place at sensibly constant pressure. The highly heated air, containing approximately 2 per cent of combustion products, then expands through a turbine which is directly connected to the air compressor and furnishes the power for driving the air compressor. The gases are discharged from the turbine with a pressure higher than that of the atmosphere, and with a temperature ranging from 900° to 1300° F. From the turbine the gases pass through a tailpipe and are finally expanded and ejected to the atmosphere through a suitably shaped nozzle at the rear of the unit. The ejection velocity of the gases is greater than the air entrance velocity.

Figure 5 is a cross-section through a Rolls Royce turbojet engine which utilizes a centrifugal compressor, a single stage turbine, and nine atomizing-type combustors.

Like the ramjet engine, the turbojet engine is a continuous flow engine. It has the advantage over the ramjet engine in that it does not depend upon the ram pressure of the entering air for its operation. The amount of

ram pressure recovered does, however, affect its overall economy and performance.

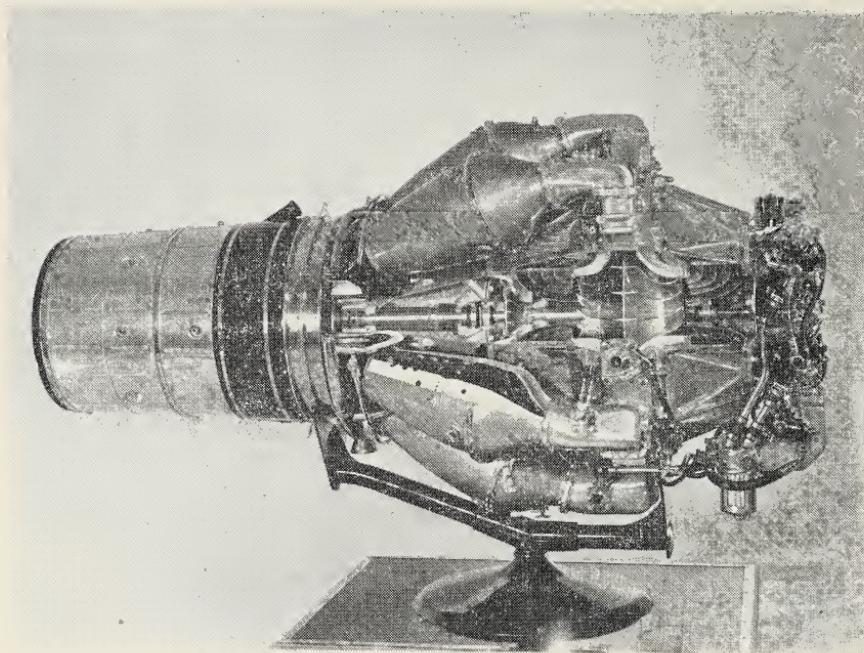


Fig. 5.—Cross Section of Rolls Royce Turbojet.

Although all of the thermal jet engines discussed have been investigated experimentally in either military aircraft or guided missiles, only the turbojet engine has been applied as the sole propulsion means for piloted aircraft. It appears to be eminently suited for propelling aircraft at speeds above 500 miles per hour, at least in the subsonic range. As the flight speed is increased still further, the ram pressure increases rapidly, and characteristics of the turbojet engine tend to change over to those of the ramjet engine. Consequently, its top speed is limited to that flight regime where it is more advantageous to use the ramjet engine. No reliable figures can be given at this time, but estimates indicate that for speeds above approximately 1200 miles per hour it will be more advantageous to use the ramjet engine.

The modern conception of the turbojet engine can be traced to a patent issued to Guillaume of France in 1922. The patent discloses the use of a gas turbine to drive an axial flow air compressor. The first reduction to practice must be credited, however, to Air Commodore Frank Whittle of England who filed his first patent on January 11, 1930. At that time, air compressors were too inefficient, the permissible operating temperatures for turbine blades were too low, and the speeds of aircraft were much

too slow to make jet propulsion attractive. His tenacity and faith in the turbojet engine were rewarded in 1937 when his first operating engine was developed. The first flight was conducted with a Gloster airplane in May 1941, and the Welland series of engines based on Whittle's designs were put into production in 1944.

In Germany, the studies of the turbojet engine were initiated as far back as 1930, and the Germans were the first to fly an airplane propelled by a turbojet engine (August 27, 1939). (Neville, 1948).

As in the case of any gas turbine power-plant, the efficiencies of the components of the turbojet engine have an influence on its performance characteristics (Streid, 1946). The performance of the turbojet engine, however, is not nearly so sensitive to changes in the efficiency of its component machines as is a gas turbine which delivers shaft power.

Turbojet propelled fighter aircraft are currently flying at speeds of approximately 650 miles per hour, and jet propelled bombers having speed capabilities of 550 to 650 miles per hour are a distinct possibility (Hage, 1948). If one judges the future by the present trends, turbojet propelled transports with speeds of 525 miles per hour are a distinct possibility in the very near future. It is reasonable to assume that once the reliability of the turbojet engine has been established, so that a 500 hour span between major overhauls can be secured, and the problems of airport traffic control for high speed aircraft have been solved, the application of the turbojet engine propulsion to commercial transport will follow rapidly. The operating experience being obtained currently with the De Haviland Comet, a jet propelled commercial aircraft, will be of great value to the future development of jet propelled commercial aircraft.

The major research problems pertinent to further development of the turbojet engine are those which must be solved to obtain the following:

- (a) more efficient, higher pressure ratio, higher flow capacity, smaller, and lighter air compressors;
- (b) more efficient and reliable turbines capable of operating at higher inlet temperatures; and
- (c) stable combustion over a wider range of operating conditions.

It is not possible in this paper to discuss all of these problems in detail, but some brief comments will be presented concerning some of the phases of current research.

It has been mentioned that two types of compressors are currently employed, the centrifugal compressor and the axial flow compressor. Irrespective of the type, the objectives are similar. The compressor must be reliable, compact, easy to manufacture, and have a small frontal area.

The centrifugal compressor has the advantage of simplicity, reliability, ease of manufacture, and high pressure ratio per stage, while the axial flow compressor has a higher stage efficiency and a smaller frontal area for a given flow capacity.

The centrifugal compressor development is hampered by the lack of an adequate theory and basic data on the flow of air through its passages. Also, it is difficult to maintain both high efficiency and high pressure ratio with either a single stage or by multi-staging. In the interests of a reasonable air compression efficiency the centrifugal turbojet engine has been restricted to employing a single stage compressor thus limiting its maximum pressure ratio of 4.5 to 1 approximately. Another drawback of the centrifugal compressor is that its flow capacity is limited by the shock phenomena of the compressor entrance. Current research is directed to obtaining a more accurate knowledge of the flow processes and means for overcoming the problems just presented.

Current axial flow compressor research is directed to increasing the pressure ratio per stage with the object of reducing the length and cost of the machine. At this time, the maximum pressure ratio per stage is approximately 1.15 to 1, but the results of research indicate that much higher pressure ratios per stage should be achievable (possibly as high as 2 or 3 to 1). In this same connection, investigations are being conducted to obtain fundamental information regarding the possibility of employing supersonic flow in the rotating blades and utilizing weak shock waves to aid in compressing the air.

Turbine research is concerned with means for reducing losses, means for cooling the blades to permit the use of higher inlet temperatures, and ways for supplanting the present construction materials (principally chrome, nickel, and cobalt alloys) with nonstrategic materials. In a turbojet engine, and also in a gas turbine which delivers shaft power, the temperature limitations are imposed by the blade materials. Currently, about 66% of the air flowing through the engine is used as a coolant to reduce the temperature of the combustion gases from their temperature of 3500° F. to a temperature permissible for the turbine blades. Current research is concerned with various methods of air or liquid cooling of the blades, the possibility of using ceramic blades, and the properties of sintered blades synthesized from nonstrategic materials. The material for turbine blades must be capable of withstanding thermal shock and oxidation at high temperatures. The National Advisory Committee for Aeronautics has devoted considerable effort to the development and investigation of materials made by sintering ceramic-metal combinations (termed ceramels) by methods similar to those used in the powdered metallurgy field. Some promising results have been obtained.

The turbojet engine, because of its rather flat thrust versus speed curve, introduces certain operational problems at take-off due to the small ratio of take-off thrust to thrust in flight. Since the exhaust gases from the turbine contain considerable excess air, the possibility of increasing the jet velocity by burning additional fuel in the tailpipe upstream to the exhaust nozzle is being investigated. Figure 6 illustrates the types of results being obtained. It is seen that "tailpipe burning" can increase the thrust at take-off by 35%, and at 500 miles per hour, by approximately 60%. The value of this additional thrust in a military operation is obvious.

The Rocket Engine.—Rocket propellants may be either liquids or solids. A rocket engine using a liquid oxidizing agent and a liquid fuel to produce high pressure, high temperature gases, is termed a bipropellant liquid rocket engine. One employing solid chemicals is termed a solid propellant rocket engine. Due to space limitations the subsequent discussions will be limited to bipropellant liquid rocket engines.

The functioning of a rocket motor differs basically from that of a thermal jet engine in two major respects:

- (1) it does not use atmospheric air; and
- (2) its thrust depends entirely upon the effective velocity of the exhaust jet, and does not depend upon a momentum difference as is the case for either a thermal jet engine or a propeller.

Because the thrust of a rocket motor depends only upon the effective jet velocity, denoted by w_{eff} , it is unaffected by the speed at which the propelled body travels if the propellant consumption rate is held constant.

The particular advantages of rocket jet propulsion may be summarized as follows:

1. its thrust is independent of its speed;
2. its thrust is practically independent of its environment;
3. it has no altitude ceiling since it does not require atmospheric oxygen for its operation;
4. it functions best in a vacuum; and
5. its thrust per unit of frontal area is the largest of any known propulsion engine.

It is the above advantages which stimulated the pioneers in the field of rocketry, because they saw that the rocket possessed the potentialities for attaining extreme altitudes and speeds, and for making escape from the earth and even space travel technical possibilities.

The aforementioned advantages of rocket jet propulsion result from the fact that the rocket propelled body carries its own oxidizer as well as its fuel. This, however, is a mixed advantage. Because the oxygen for burning the fuel is not taken from the atmosphere, the rate at which a rocket engine consumes propellants (oxidizer plus fuel) is several times the rate at which a thermal jet engine consumes fuel, the only combustion component carried in the thermal jet propelled body or vehicle.

To illustrate, a rocket engine developing 10,000 lb. thrust will consume approximately 45 lb. of propellants per second, while a turbojet engine developing 10,000 lb. thrust at sea level will consume only 2.8 lb. of fuel approximately in the same length of time. Because of its enormous rate of propellant consumption the operating time of a rocket, called its *powered flight*, is extremely short. For example, the powered flight of the German V-2 missile was 67 sec and that for the Viking Sounding Rocket 75 sec.²

² "Advance Man to the Moon," Aero. Digest, October, 1951, p. 26.

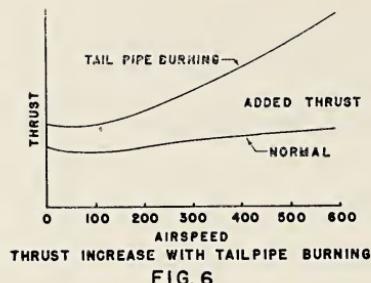


FIG. 6

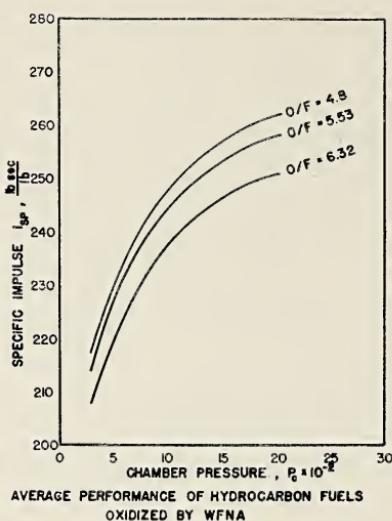


FIG. 8

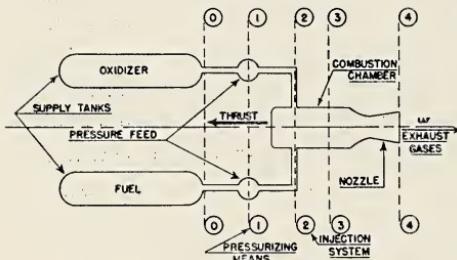


FIG. 7

Fig. 6.—Thrust Increase with Tailpipe Burning.

Fig. 7.—Elements of Liquid Rocket System.

Fig. 8.—Average Performance of Hydrocarbon Fuels Oxidized by WFNA.

The enormous rate of propellant consumption limits the endurance of a rocket propelled airplane, and consequently its range, to small values. For a rocket propelled vehicle to achieve a large range, the vehicle must be propelled so that it has large velocity and a high altitude at the end of the *powered flight*. The large kinetic energy of the vehicle is then utilized to achieve range by coasting; that is, it must have a ballistic type of trajectory. To obtain the required velocity at the end of powered flight a large thrust must be imparted to the vehicle for a relatively short time, a minute or two.

The large thrust per unit area developed by the rocket engine and the fact that its thrust is more or less independent of the altitude does, however, give a rocket propelled airplane a decided performance advantage.

Figure 7 illustrates the essential features of a bipropellant liquid rocket motor. It comprises an injector, a combustion chamber, a DeLaval exhaust nozzle, and propellant control valves. In addition it is equipped with a regenerative cooling system for keeping the walls exposed to the high temperature gases at a safe operating temperature; one of the propellants is circulated around the combustion chamber and nozzle before being injected into the combustion chamber.

The rate of flow of the propellants into the combustion chamber and the mixture ratio (oxidizer weight rate of flow/fuel weight rate of flow) are governed by the areas of the respective injection orifices and the differential pressures acting upon them. The pressure of the combustion gases depends upon the throat area of the exhaust nozzle. The combustion gases are ejected to the atmosphere with supersonic velocity, with speeds ranging from 6,000 to 11,000 feet per sec., depending upon the propellant combination. The combustion pressures generally range from 300 to 800 psia (pounds per square inch, absolute).

The performance of a rocket propellant combination is expressed in terms of either its specific impulse I_{sp} , the impulse obtained from reacting one pound of the propellant combination, or its effective exhaust velocity w_{eff} . If F denotes the thrust, G_p the rate of propellant consumption, and g the gravitational acceleration, then

$$w_{eff} = \frac{gF}{G_p} = gI_{sp} \quad (2)$$

If the thermodynamic properties of the combustion gases are either known or estimated from thermo-chemical calculations, the specific impulse can be calculated. Otherwise it must be determined by experiment.

One of the most potent common propellant combinations is liquid oxygen-liquid hydrogen, which gives an exhaust velocity of 10,800 feet per sec. This is a difficult combination to handle in practice. Liquid oxygen boils at -190°C . and liquid hydrogen boils at -252°C ., making the storage problem exceedingly difficult; moreover, liquid hydrogen manufacturing facilities are practically unavailable. More widely used combinations are liquid oxygen-alcohol, and nitric acid in combination with a variety of fuels. The search for better and more potent propellants continues, and investigations in the propellant field have been concerned with materials varying from powdered metals to fluorine and its derivatives. Unfortunately the results obtained so far are not too encouraging in the hope of finding a chemical propellant combination having a specific impulse significantly larger than that obtainable from the liquid oxygen-liquid hydrogen combination (335 sec.).

The specific impulse of a rocket propellant combination can be increased by reacting the propellants at higher combustion pressures than are normally utilized. Figure 8 presents the calculated values of the specific impulse for white fuming nitric acid (WFNA) reacted with hydrocarbon fuels at different combustion pressures, and different oxidizer fuel ratio by weight (Trent, *et al.*, 1949).

The operation of rocket motors with either higher energy propellants or at high combustion pressures leads to very high rates of heat transfer to the metal walls if they are to be maintained at a safe operating temperature. An appreciation of the heat transfer problem can be obtained from

Table I which presents measured values of the heat transfer rates for rocket motors burning white fuming nitric acid (WFNA) and jet engine fuel (JP-3) at 300, 500, and 700 psi combustion pressure (Zucrow and Beighley, 1952).

Table I.

MEASURED VALUES OF THE MAXIMUM HEAT TRANSFER RATES
FOR WFNA AND JP-3

(Obtained from three different rocket motors each designed for 500-lb. thrust and $L^* = 100$ in.)

Heat transfer rates in B.t.u. per sq. in. per sec.

MEASURED VALUES

Combustion pressure (psia)	Thrust cylinder Ratio,	Nozzle Ratio,	Rocket motor Ratio,			
	q_c	$\frac{q_c}{(q_c)_{300}}$	q_n	$\frac{q_n}{(q_n)_{300}}$	q_o	$\frac{q_o}{(q_o)_{300}}$
300	1.3	1.00	2.8	1.00	1.7	1.00
500	2.2	1.69	4.0	1.43	2.6	1.53
700	2.3	1.77	6.0	2.14	3.5	2.06

It should be noted that the overall heat transfer rate for the nozzle at 700 psia combustion pressure was 6.00 B.t.u. per sq. in. per sec. (3×10^6 B.t.u. per sq. ft. per hr.). That value is considerably below the peak value which occurs at the throat, which is difficult to measure. Estimates indicate that the peak value at the throat is probably twice the overall for the nozzle.

It was pointed out earlier in this paper that to achieve a long range the rocket propelled vehicle must follow some form of ballistic trajectory. The question of the best trajectory and the best programming of the thrust has been studied by several investigators, and that type of investigation needs continuing effort. One of the major problems is the proper programming of the angle of attack of the rocket propelled vehicle as it re-enters the atmosphere after descending from an extreme altitude. Since the velocity of the vehicle at re-entry will be practically the same as that which it had on leaving the atmosphere, some means for reducing its speed is necessary, so that its skin will not become overheated and a safe landing speed can be achieved. Calculations by H. S. Tsien (ARS, 1 Dec. 1949) on a 3000 mile range rocket propelled vehicle show that these objectives are not at all beyond the grasp of present day technology.

World War II witnessed the development and application of a variety of rocket weapons. The incentives for developing them were the small weight of rocket launchers, compared to artillery pieces, for large-caliber projectiles, the freedom of the rocket launcher from recoil, and the need for equipping infantrymen and military aircraft with light-weight large-

caliber weapons. Furthermore, the possibilities of the rocket as the propulsion plant for long range missiles were demonstrated by the German V-2 rocket-propelled missile. The Germans also demonstrated the possibilities of the rocket as a propulsion system for extremely fast interceptor aircraft, the ME 163 airplane, propelled by a liquid-propellant rocket power plant.

Rocket developments in the United States during World War II were concerned primarily with their application as infantry and aircraft weapons, as jet-assisted take-off (JATO) units for aircraft, and for super-performance of aircraft at high altitudes. Both liquid and solid propellant rocket engines were employed for those applications.

Since World War II rocket jet propulsion has been applied to guided missiles, for launching ramjet engines, and as a research tool in aeronautics. In the latter connection, rockets have been applied to the propulsion of aerodynamic models in free flight, for obtaining data on aerodynamic forces and control-surface effectiveness, and to the propulsion of such research aircraft as the Bell X-series and the Douglas D-558 series, for obtaining quantitative data on drag, stability, air loads, etc., at supersonic flight speeds. The rocket has also been employed for propelling sounding rockets, such as the Viking, for obtaining data on the properties of the upper atmosphere.

Despite its apparent simplicity, the development of reliable rocket power plants having good performance characteristics (a satisfactory thrust/weight ratio) requires solving a large number of perplexing problems. The complete rocket system must be light in weight, and the rocket motor must be capable of sustained operation with gases at temperatures higher than 5000° F. flowing through it. Many of the propellants utilized in liquid propellant rocket power plants are extremely corrosive which introduces major material problems. Furthermore, owing to the enormous energy releases, high gas pressures, and high gas temperatures, problems of rapid ignition of the propellants, smooth start-up, stable combustion, precise control of the oxidizer/fuel ratio under accelerating and angle of attack conditions, thrust control, adequate cooling, material selection, and several others are encountered. In the case of turbo-pump pressurized rocket engines there are problems pertinent to the development of extremely light-weight high-speed (16,000 to 30,000 revolutions per minute) rotary machines of large capacity, with their cavitation, sealing, and bearing problems. In addition, the development of light-weight high-temperature gas generators, for driving the turbine, introduces system control and material problems.

Conclusions.—Jet propulsion engines, whether of the thermal jet or rocket jet types, should not be regarded as competitors of the piston engine-propeller propulsion system in the low and moderate flight speed range. They are power plants for realizing objectives which are unattainable with the piston engine propeller drive. When the propulsion of aircraft at speeds significantly faster than 450 miles per hour is being considered, jet propulsion engines, such as the turbojet, the ramjet, and the rocket,

are the only engines that possess the capabilities of realizing such objectives. The turbojet is in current use as the propulsion plant for military high speed subsonic aircraft. For short duration supersonic flight at extreme altitudes, for extremely fast climbing interceptor aircraft, for jet assisted take-off, and guided missile propulsion, the rocket engine has demonstrated its potentialities.

At present, the power plant field related to the propulsion of bodies through the air at extremely high speeds is in a state of flux. Several promising power plants are available for attaining different objectives. Intensive development of these newer engines and their combinations are in progress, and the era of truly highly speed flight is on the horizon.

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Characters of Systematic Importance in The Family Branchiobdellidae (Oligochaeta)¹

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Recent morphological and systematic studies have revealed hitherto unsuspected relationships between genera of the Branchiobdellidae and indicated the importance of variations in the internal anatomy as features of systematic significance. This paper is concerned with an evaluation of systematic characters.

Previous works with similar aims are meager. Hall (1914) considers the external form, preoral lobe, the structure of the dental plates, and the structure of the genitalia as systematic characters. Ellis (1919) discusses the dentition, the pharyngeal diverticula, and the "buttress-like supports of the intersegmental partitions" as features of systematic importance. In a previous work (1912) he took into account the number of the anterior nephridiopores and the structure of the male reproductive system. Yamaguchi (1934) states that Pierantoni (1912) attached much importance to the "ventral cirri", dorsal appendages of the trunk, the form of the peristomium, the structure of the dental plates; and the number of pairs of testes and male funnels. Yamaguchi himself discusses the dorsal appendages and ridges, the peristomium, and the "pharyngeal diverticula". Goodnight (1940) evaluates the systematic importance of the following characters: body shape, dorsal appendages, peristomium, jaws and dentition, position of the caudal sucker, shape of the gut, pharyngeal diverticula, opening of the anterior nephridia, number of testes, accessory sperm tube, penis, and shape of the spermatheca.

There follows a brief review of these and some other characters in the light of the studies mentioned above.

1. *Body shape*.—The flattened bodies of *Xironodrilus* and *Xironogiton* are distinctive and set these two genera sharply apart from all other genera of branchiobdellids. The tapering body of *Xironodrilus* is distinct from the "tennis racket" shape of *Xironogiton*.

2. *Dorsal appendages*.—Excluding the Japanese forms, the genera *Pterodrilus* and *Cirrodrilus* are readily separable from the remaining American genera by possessing dorsal appendages, and the variations in the appendages are of specific value in *Pterodrilus*. Whether *Cirrodrilus* can be separated from *Pterodrilus* is doubtful. Not available to me until recently, specimens of *Cirrodrilus thysanostomus* (Hall) appear to have many other features in common with the species of *Pterodrilus* in addition to the presence of dorsal appendages that resemble those of *Pterodrilus alcicornis*. The raised annuli of certain species of *Cambarincola* (e. g., *C.*

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chirocephala) approach the dorsal appendages of *Pterodrilus* and present even more of a problem than *Cirrodrilus*, since it is only by means of the dorsal appendages that *Pterodrilus* and *Cambarincola* can be separated. Nonetheless the varying forms of the dorsal appendages are useful characters of specific value and are the only ones that can be utilized in separating the genera *Pterodrilus* and *Cambarincola*.

3. *Peristomium*.—As pointed out by Ellis (1919), Yamaguchi (1934), and Goodnight (1940) the plurilobate, or better, the tentaculated, peristomium occurs in such diverse genera as *Branchiobdella*, *Stephanodrilus*, and *Cambarincola*, and is of no generic value. There may be some differences, however, in the arrangement of the tentacles associated with other generic characters. In *Cirrodrilus*, for instance, there are four dorsal tentacles that flare, and a lateral tentacle on each side of the mouth, while among those species of *Cambarincola* possessing tentacles, there are four dorsal tentacles that are shorter, do not flare so noticeably, and the lateral tentacles are absent.

4. *Jaws*.—The significance of the number of teeth borne by the jaws of the branchiobdellids is a vexing problem. Ellis (1919) has attempted to classify the types of jaws and devised a system for expressing the dental formula by means of capital letters for the larger teeth and lower case letters for the smaller ones. It is my feeling that the shape of the jaws should be considered along with the number of the teeth and that dental formulae, although usable, are not solely to be relied upon in the diagnosis of species.

5. *Position of the caudal sucker*.—Considered a generic character by Goodnight, the ventral suckers of *Xironodrilus* and *Xironogiton* are a consequence of the depressed body form of these genera and are considered along with this character as an additional feature that separates these genera from the remaining ones which belong to the family.

6. *Shape of the gut*.—The shape of the gut does change with the amount of contained food and the degree of contraction of the body; but the expansions of the gut seem to occur in a characteristic fashion in certain segments in given groups of species; for instance, the expansions of the gut in segments II, III, and IV, with sharp constrictions between these expansions, and with the gut proceeding along a straight course to the anus is a characteristic of the genus *Xironodrilus*. Goodnight's view that the shape of the gut is of only dubious specific value is, therefore, rejected.

7. *Pharyngeal diverticula*.—Ellis (1919) in a search for characters of taxonomic significance was impressed with the "pharyngeal diverticula". These "diverticula" are encircling folds of the pharyngeal wall and are permanent structures determined by the manner of attachment of the radial dilator muscles of the pharynx. There are two of these folds in the pharyngeal wall, but the posterior one is often obscured by the degree of contraction of the animal. Since they appear to be commonly found throughout the family, being present in essentially the same form in all of the species of the five genera that I have investigated, they are of no diagnostic significance.

8. *The manner of opening of the anterior nephridia.*—The common opening of the anterior nephridia through a bladder-like dilatation which opens to the outside by a mid-dorsal pore on segment III is characteristic of a group of genera. Difficult to detect in ordinary preparations, and hence of no great practical value as a diagnostic character, the manner of opening of the anterior nephridia may be of considerable value in evaluating the relationships between groups of genera.

9. *The male reproductive system.*— —

a. The number of testes — Not having had an opportunity to study the genus *Branchiobdella*, which is characterized by the possession of only one pair of testes in segment V, I can say nothing in regard to the use of this character by Goodnight (1940) in dividing the family into the subfamilies *Branchiobellinae* and *Cambarincolinae*. Certainly such a variation in the reproductive system is of considerable value in separating groups of branchiobdellids.

b. Spermatheca — Practically all previous workers have mentioned the organ that is here called the spermatheca; however, only Moore (1894, 1895), and more recently Holt (1949), among American workers, have described this organ with any degree of consistency and accuracy, and Moore failed to do so in the case of *Pterodrilus alcicornis*. The only exception to this statement is Ellis' (1912) figure of *Cambarincola macrodonta*. This confusion has usually been associated with a failure to understand the proper relationship of the accessory sperm tube to the spermatheca. That the variations that may occur in the shape and proportions of the spermatheca are of systematic importance is illustrated by the species of *Xironodrilus*.

c. Accessory sperm tube — I have shown previously that this structure is not to be confused with the blindly ending proximal portion of the spermatheca of *Xironogiton* (Holt, 1949), and more recently (in ms.) the existence of the accessory sperm tube has been demonstrated for the first time in *Pterodrilus*. The presence or absence of this feature of the male reproductive system is of generic value and the degree to which it is separated from the spermatheca and its relative size is of specific value.

d. Ejaculatory duct — The presence or absence of an ejaculatory duct is of specific value in the genus *Xironodrilus*. In all other genera that I have studied it is present, but its relative proportions vary, and these variations may be of specific significance.

e. Bursa — In the genera *Pterodrilus* and *Cambarincola* the relative size and shape of the bursa is useful in distinguishing the several species belonging to them, and it seems probable that the same may be true for separating the species of the genus *Xironogiton*.

f. Penis — The eversibility or non-eversibility of the penis has been considered as of generic value by Goodnight (1940), but there are species of *Cambarincola* (the genus cited by Goodnight as having non-

eversible penes) with eversible penes (Holt, in mss.). Thus this character cannot be accorded generic distinction, but it is a useful one in diagnosing certain species.

10. *The female reproductive system. — —*

a. Spermatheca — The shape of the spermatheca is of specific value in some groups (e. g., *Pterodrilus*), while in others there may be a wide range of intraspecific variability in this organ (e. g., *Xironodrilus pulcherrimus*). The bifid character of the spermatheca of *Bdellodrilus illuminatus* has been considered a generic character.

11. *Glands.*—The lateral glands present in the nine postcephalic segments of *Bdellodrilus illuminatus* are undoubtedly of systematic importance. The lateral "adhesive organs," located on segments VIII and IX of members of the genus *Xironodrilus*, have been considered of generic importance (Goodnight). It should be pointed out, however, that Ellis (1919) described "glandular adhesive disks" for *Xironogiton occidentalis*, but the assignment of this species to the genus *Xironogiton* is suspect. The greatly flared, lateral portions of segments V to VIII of the other species of *Xironogiton* are glandular and a critical evaluation of the "adhesive" organs in the closely related genera is impossible at present.

SUMMARY

Of the characters described above, the "pharyngeal diverticula" are of no diagnostic value. The shape of the body, the dorsal appendages, the general shape of the jaws, the position of the caudal sucker, the shape of the gut, the manner of opening of the anterior nephridia, the number of pairs of testes, the presence or absence of the accessory sperm tube, the bifid spermatheca, and the presence of lateral glands are of generic importance.

Variations in the dorsal appendages, the tentaculated peristomium and its variations, to a limited extent variations in the shape of the jaws and the number of teeth, the shape and proportions of the spermatic vesicle, the proportions of the accessory sperm tube, the presence and proportions of the ejaculatory duct, the relative size and shape of the bursa, the eversibility of the penis, and the shape of the spermatheca are of specific value.

These studies emphasize the necessity for making careful studies of the internal anatomy of the branchiobdellids. Only in this way can accurate systematic work be done. Formerly the genera *Xironogiton* and *Cambarincola* were considered to possess the accessory sperm tube in common. Actually these two genera are far removed from each other in the subfamily Cambarincolinae and the accessory sperm tube is absent in species of *Xironogiton*. On the other hand Moore's reference to the "cleft atrium" of *Pterodrilus* has been overlooked, along with the relationship of this genus to *Cambarincola*.

I am confident that many new species of branchiobdellids will be recognized as closer attention is paid to the features discussed above, particularly the variations that occur in the male reproductive system.

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* Not seen in the original.

The Chromosomes of the Polygyrid Snail *Allogona profunda*¹

LADLEY HUSTED

University of Virginia

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Radford College

Virginia Polytechnic Institute

The family Polygyridae is the most widely spread group of helcid snails in North America. Four of the genera of the family are known in Virginia: *Stenotrema*, *Mesodon*, *Triodopsis*, and *Allogona*. In an earlier report (Husted and Burch, 1946) the chromosomes of eighteen species and subspecies of the first three of these were described and discussed in some detail. We are now concerned with the fourth genus, *Allogona*.

Allogona is represented by three species. One, *A. profunda*, is found in the Ohio valley and eastward, in the upper and middle Mississippi and lower Missouri valleys. It extends as far west as Nebraska and Kansas and a little farther north. Two species, *A. townsendiana* and *A. ptychophora*, are separated by approximately 800 miles from *A. profunda* and found west of the continental divide in Montana, Idaho, Oregon, Washington, and British Columbia (Pilsbry, 1940).

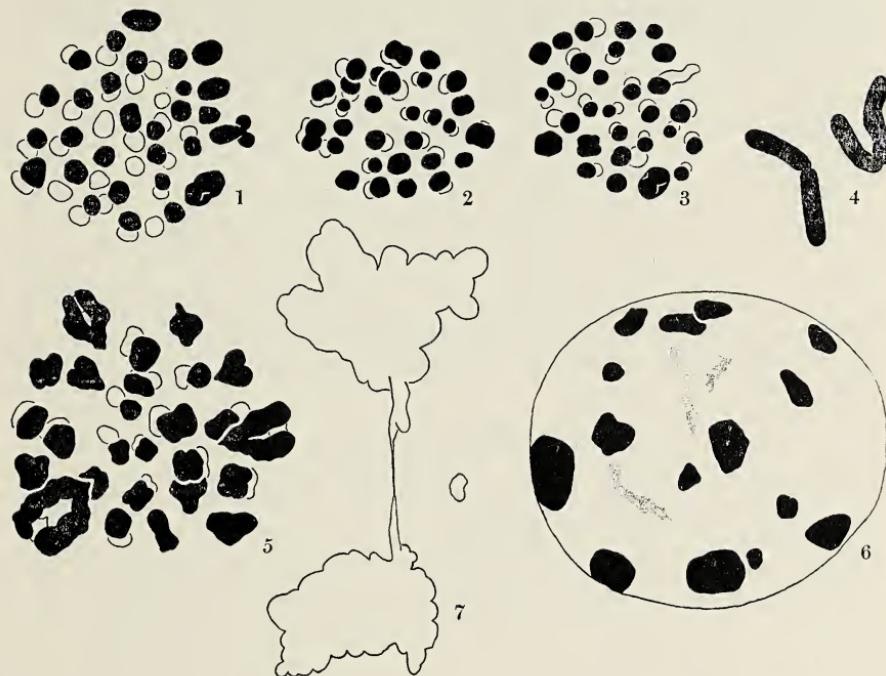
According to Pilsbry, this primitive genus is characterized chiefly "by the possession of a strongly developed stimulator in the penis, — a structure not known in any other Polygyridae, — and an epiphallus with vestigial concealed flagellum. Except that the penial sheath is mainly or wholly adnate to the penis, the organization is otherwise about as in *Triodopsis*."

We have examined two individuals of *A. profunda* found on Wolf Creek in Giles County, Virginia. They had epiphragms over their apertures when collected and were fed in a humid aquarium for one week before the ovotestes were prepared for study. The method of fixing and staining described by Husted and Burch, (*l. c.*) was followed. These differ cytologically from the other Virginia genera of the family in three ways: the chromosomes are larger, fewer in number, and spermatogonial nuclei contain chromosomes which in certain regions at least are conspicuously heterochromatic.

The largest chromosomes of *Stenotrema*, *Mesodon*, and *Triodopsis* at metaphase I (Figs. 1-3) are only slightly larger than the smallest found in *A. profunda* (Fig. 5). At metaphase of the last spermatogonial mitosis

¹ The cost of collecting this material was partly defrayed by a grant from the Virginia Academy of Science.

the largest *profunda* chromosomes (Fig. 4) are nearly 8 micra in length while comparable chromosomes in the other genera are less than 5.



EXPLANATION OF FIGURES.—The chromosomes of four species of Polygyridae. Fig. 1. *Stenotrema monedon aliciae*. Fig. 2. *Mesodon rugeli*. Fig. 3. *Triodopsis tridentata edentilabris*. Fig. 4. Two of the largest chromosomes of *Allogona profunda* at mitotic metaphase. Fig. 5. *Allogona profunda*, twenty-six bivalents. Fig. 6. Spermatogonial nucleus showing heterochromatin and a small portion of the euchromatin. Fig. 7. *A. profunda*, bridge and fragment, Anaphase I. X2651.

The chromosome number of species of *Stenotrema*, *Mesodon*, and *Triodopsis* found in southwestern Virginia is characteristically 58. *Mesodon appressus* has 58 chromosomes in Virginia but is known in New Jersey with 62. *Triodopsis fraudulenta* may have 58, 59, 60, or 62 chromosomes. These supernumerary chromosomes resemble the others of the complement in behavior and, as far as can be determined, in structure. The two individuals of *Allogona* we have analyzed have 52 chromosomes, 6 less than are found in the "more highly evolved" relatives that have been examined. These chromosomes are regular in their behavior forming 26 bivalents at meiosis (Fig. 5). They are uniformly and intensely stained

by the Feulgen reaction at meiotic metaphase I. In spermatogonial cells at rest or in prophase, however, numerous deeply stained masses differentiated from the less deeply stained euchromatin occur (Fig. 6). These heterochromatic regions, which were not seen in *Stenotiema*, *Mesodon* and *Triodopsis*, appear at prophase to occupy interstitial and terminal portions of certain chromosomes in both spermatogonia and oocytes.

In one individual evidence for structural hybridity is found in cells at anaphase I (Fig. 7). The chromatid bridges, each accompanied by a fragment, are the first encountered in a thorough examination of 129 polygyrid snails.

The chromosomes of all the genera of the Polygyridae in Virginia are now known. The "primitive" *A. profunda* with 52 chromosomes, or 6 less than the related species in this region, is in agreement with our earlier suggestion that the gradual increase in chromosome number characteristic of the pulmonata, and demonstrated in *Triodopsis fraudulenta*, may be attributed to the duplication of chromosomes one or two at a time. In this connection a study of the west coast species of *Allogona* would be of interest.

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Note on Egg-laying of the Four-toed Salamander, *Hemidactylum scutatum* (Schlegel), in Eastern Virginia

OLLIE KING GOODWIN
Box 521, Warwick, Virginia

JOHN THORNTON WOOD¹
University of Virginia

A recent survey (Wood, 1951) provides information on the nesting of the Four-toed Salamander, *Hemidactylum scutatum* (Schlegel), in Virginia. The egg-laying period for this species was reported to extend from February 24 to March 10, 1951 (Wood, *ibid.*; Wood and Wilkinson, 1952). Additional information on the nesting of this species was obtained on a field trip on February 17, 1952 to a branch pond located one-half mile southeast of Harpersville, Warwick (formerly Warwick Co.), Virginia. Five groups of adults were found along the margin of the pond in Sphagnum hummocks surrounded by water. The number of adults in each group, and the number of eggs present, were as follows:

GROUP NUMBER	1	2	3	4	5
NUMBER OF ADULTS	2	3	2	3	1
NUMBER OF EGGS	—	150	—	145	34

All of the adults were females with full or spent ovaries. This observation at the beginning of the egg-laying period is evidence that gregarious nesting occurs as early as nesting occurs, and is not the result of lack of suitable discrete habitats in which nests can be placed. It is also evidence that females will deposit their eggs in nests containing the eggs of other females while the earlier nesting females are still in attendance. No competition between the gravid females and those with spent ovaries has resulted in the driving of the latter away from the nests. Noble (1930) has suggested that in the case of the Marbled Salamander, *Ambystoma opacum* (Gravenhorst), exhaustion accounts for the female remaining with her eggs. No assay of the extent of exhaustion following the egg-deposition of these females was attempted, but it was noted that when disturbed they sought refuge by quickly scrambling into the adjacent water. They did not appear to retreat more slowly than is usual in this species when specimens are encountered in habitats other than nesting sites under similar conditions of temperature.

¹ Box 534, Williamsburg, Virginia.

Of particular interest was the observation that most of the eggs in each of the egg groups were submerged. The finding of submerged *Hemidactylum* eggs has not been reported previously in the literature, although Wood (*ibid.*) found that submerged eggs will develop into larvae in this species. The moss hummocks in which the eggs were found were surrounded by water, and were located a few inches from the shore. The authors did not interpret these sites as permanent insular locations because it is entirely possible that heavy rainfall on the previous night raised the water level enough to isolate the hummocks from the shore and submerge most of the egg masses. Females have never been observed depositing eggs under water, and the females attending these partially submerged nests were not in the water when first observed.

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News and Notes

(Editor's note: News contributions should be sent to the person whose name appears at the end of the appropriate section.)

SECTION NEWS

BACTERIOLOGY SECTION

The Virginia Branch of the Society of American Bacteriologists held a meeting in the Department of Microbiology, University of Virginia, on Saturday, December 6, 1952. The following is an outline of the program of the meeting.

11:00 A.M. — Business Meeting.

12:00 Noon — Luncheon.

2:00 P. M. — Scientific Session.

A Study of Dogs as Vectors of *Salmonella* in the Area of Richmond, Virginia.
William Paul Bennett; *Department of Biology, University of Richmond.*

Rice Products in the Cultivation of *Endamoeba histolytica*.
E. Clifford Nelson and Muriel M. Jones; *Department of Bacteriology and Parasitology, Medical College of Virginia.*

Beneficial Effects of Egg White in Viral Complement Fixation Tests.
(and) Techniques for Making Permanent Reading Standards for the Determination of Total Proteins in Spinal Fluid Specimens.
C. A. Crooks, Jr.; *City Health Department, Richmond.*

A Microcolony Technique for the Rapid Determination of Bacterial Sensitivity to Antibiotics.
H. J. Welshimer, Muriel M. Jones, and C. D. Gibson, Jr.; *Departments of Bacteriology and Parasitology, and Medicine, Medical College of Virginia.* — J. DOUGLAS REID, R.F.D. 13, Richmond.

BIOLOGY SECTION

The Department of Biology of the University of Virginia has a three section greenhouse, 85 x 25 feet in size, now under construction. Associated with the greenhouse is a building which will provide additional laboratory space, and quarters in which birds and mammals for research use in Parasitology, Physiology, and Genetics will be housed. New laboratories are also being equipped for work in General Physiology, Plant Physiology, and Morphogenesis.

Mr. D. W. Bierhorst, Instructor in Botany, University of Minnesota, has been appointed Assistant Professor of Biology at the University of Virginia, effective September 1953. He will offer courses in Evolution, Plant Ana-

tomy, and Morphogenesis to graduate and advanced undergraduate students.

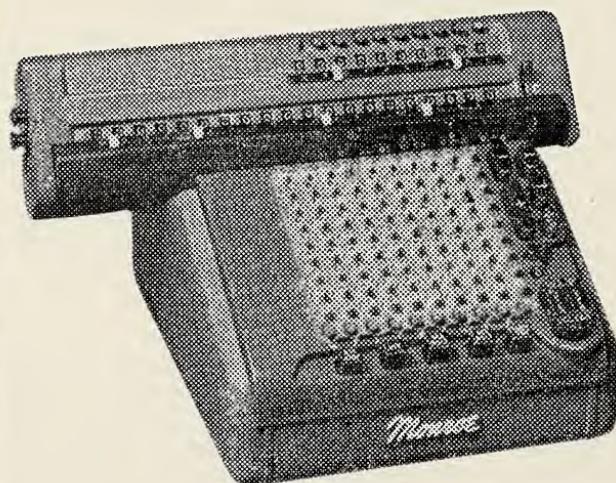
The Conservation Committee of the Academy (J. J. Shomon, Chairman) appeared before the State Board of Education on Thursday, February 26, to appeal for the re-establishment of the position of Conservation Counselor with the State Department of Education.

Another conservation item of interest is the recent organization of a Virginia Resource-Use Education Council, composed of representatives from State and Federal agencies. The function of the Council is to promote and correlate the various efforts of conservation education throughout the State. The secretary of the council is R. R. Bowers, Commission of Game and Inland Fisheries, 7 North Second Street, Richmond.

J. T. Baldwin, Jr. of the College of William and Mary is editing a popular book on the Dismal Swamp. It is sponsored by the Virginia Academy of Science and is being written by Mr. Baldwin and ten collaborators.

Miss Patricia Casey, a 1952 graduate of Mary Baldwin College, is now a technician in the Laboratory of Hematology in the City-County Hospital in Dallas, Texas.

Another Mary Baldwin graduate, Miss Janet Russell, is employed in the histology laboratories of the Sloan-Kettering Institute for Cancer Research in New York City. — ROBERT T. BRUMFIELD, *Longwood College*.



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STATISTICS SECTION

A brochure on the Department of Statistics and the Statistical Laboratory of the Virginia Polytechnic Institute has been prepared and is available for distribution. This brochure explains courses of study offered in the Department of Statistics as well as the research and consultation of the Statistical Laboratory.

Paul Somerville of the Institute of Statistics, University of North Carolina, and W. J. Youden of the National Bureau of Standards, spoke at graduate colloquia at Virginia Polytechnic Institute.

An all-day conference on statistics and I. B. M. procedures was held at Virginia Polytechnic Institute on Wednesday, March 4, 1953. R. A. Bradley spoke on "Some Uses of I. B. M. Equipment in Statistics" and Boyd Harshbarger spoke on "Statistics at Virginia Polytechnic Institute."

C. Y. Kramer has completed work for his Master of Science degree in statistics at Virginia Polytechnic Institute.

The Department of Statistics at Virginia Polytechnic Institute is conducting a study for the State Highway Department, Commonwealth of Virginia, on certain matters relating to highways.

Boyd Harshbarger presented an invited address, "Some Lattice Designs", as the seventh lecture of a series of lectures sponsored by the Departmental Committee on Experimental Design and the Agricultural Research Administration, in the Department of Agriculture Auditorium, Washington, D. C., and at the Bureau of Plant Industry, Beltsville, Maryland.

The following papers have been published by members of the Virginia Polytechnic Institute Statistics Department:

1. The Estimation of Parameters from Sequentially Sampled Data on a Discrete Distribution, by M. C. K. Tweedie. *The Journal of the Royal Statistical Society, Series B (Methodological)*, Vol. XIV, No. 2, 1952.
2. The Rank Analysis of Incomplete Block Designs I—The Method of Paired Comparisons, by Ralph A. Bradley and M. E. Terry. *Biometrika* 39, 1952.

Reprints of the above papers are available.

R. A. Bradley is chairman of the Eastern Regional Program Committee, Institute of Mathematical Statistics. The following are members of the Program Committee, Biometric Society (Eastern North American Region): Boyd Harshbarger, (chairman), and Alonzo Myster.

The next eastern regional joint meeting of these societies will be held in the South Building of Agriculture, Washington, D. C., April 29, 30, and May 1. — W. A. HENDRICKS.

NOTES

Through errors the following abstracts of papers presented at the Thirtieth Annual Meeting of the Academy at Old Point Comfort, May 16, 1952, were not included in the Proceedings (*Va. Jour. Sci., N.S., 3 (4), 1952*).



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A Means Whereby Bacteria-Free Inocula of *Histomonas meleagridis* may be Obtained.

Arthur P. Harrison, Jr. and P. Arne Hansen; *Department of Bacteriology and the Livestock Sanitary Service Laboratory, University of Maryland, College Park.*

The livers of 24 turkeys which died of infectious enterohepatitis (blackhead) were sampled and 17 found to contain bacteria. On the other hand, of the livers from 36 turkeys sacrificed at the first appearance of symptoms, only 12 yielded bacteria. The discovery that early in the disease a high proportion of the livers from birds having blackhead are bacteria-free provides a useful method of acquiring *Histomonas meleagridis* inocula free of contaminating bacteria. Hence, it becomes feasible to experiment with pure cultures of the histomonad furnishing further evidence of the etiological role of this protozoon in blackhead disease.

The method used to acquire bacteria-free inocula of *Histomonas meleagridis* consists merely of sacrificing pouls at the first appearance of symptoms and aseptically macerating their livers. The resulting liver suspension may be used in experiments which require *Histomonas meleagridis* inocula, but paralleling these experiments a portion of the suspension is tested for bacterial sterility as follows: A few mls. from the initial dilution are added to tubes of turkey serum — Ringer's solution-rice starch medium. In addition, aerobic EMB and anaerobic Eugonagar pour plates are prepared. Incubation is for two days at 41°C.

Cell Division in the Epidermis of the Foetuses and Young Lambs of Karakul Sheep.

Lubow A. Margolena and Ethel H. Dolnick; *Animal Fiber Laboratory, Bureau of Animal Industry, U. S. Department of Agriculture.*

Growth of hair follicles and their fibers depend on the proliferation of the original epidermal cells. Hence, foetal and lamb skins of Karakul sheep were observed with particular attention to follicular development and mitoses in the epidermal cells. Skin samples were taken immediately following death. The animals were sacrificed between 9:00 and 11:00 A.M. Fixation was in Bouin's solution; final dehydration in butyl alcohol; sections were cut about 10 microns thick; and staining was by two haematoxylin procedures, a connective tissue stain, and Feulgen's reaction.

Counts were made of no less than 5000 nuclei of epidermal cells per sample from 20 foetuses ranging from 45 to 147 days (full gestation in sheep being about 150 days). Data on lamb skins of 16 animals, varying in age from one to 30 days, were collected in similar manner. All figures were expressed in percent of mitotic nuclei to total metabolic nuclei. Our mitotic counts are relatively low, yet they show a trend sufficiently clear to state that, both in the dorsal and ventral epidermis, mitotic activity is about 10 times as great just prior to and during the very early hair anlage as compared to the period of rapid proliferation and differentiation of the follicular cells. This intense follicular development

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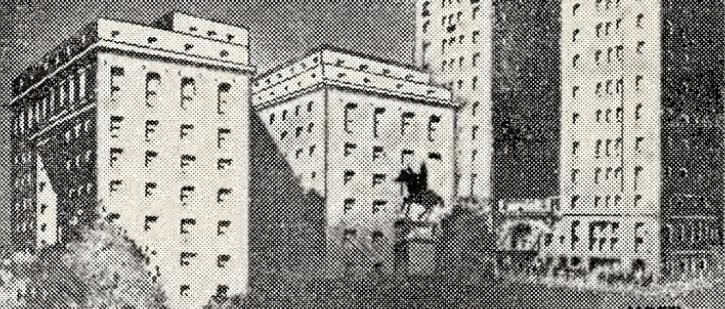
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falls within 90 or 100 days of intro-uterine life. Data show that mitoses in the epidermal cells of the ages examined never reach the high peak of the immediate pre-follicular stage.

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WEDNESDAY, MAY 6

- 3:00 P.M. to 8:00 P.M. — Registration for Junior Academy members, participants in the Science Talent Search, Academy members, and guests, Room 354, Mallory Hall.
- 3:00 P.M. to 8:00 P.M. — Setting up Exhibits: Commercial, Rooms 335, 341, Mallory Hall; Free, Room 359, Mallory Hall; Junior Academy, Rooms 435, 441, 459, Mallory Hall.

THURSDAY, MAY 7

- 8:00 A.M. to 8:00 P.M. — Registration for Junior and Senior Academy members and guests, Room 354, Mallory Hall.
- 9:00 A.M. — Meeting of Science Exhibit Judges; Room 434, Mallory Hall.
- 9:30 A.M. — Meeting of chairman and exhibitors; Room 434, Mallory Hall.
- 10:00 A.M. to 12:30 P.M. and 1:30 P.M. to 4:00 P.M. — Finalists of Talent Search meet with Chairman and interviewers; Rooms 434, 442, 454, 242, 249, 252, Mallory Hall.
- 10:00 A.M. to 12:30 P.M., 1:30 P.M. to 4:00 P.M. — Judging of Science Exhibit Contests; Rooms 45, 441, 459, Mallory Hall.
- 3:00 P.M. — Meeting of the Talent Search Committee; Room 434, Mallory Hall.
- 3:30 P.M. — Meeting of all Senior Academy Section Officers; Room 257, Mallory Hall.
- 4:00 P.M. — Meeting of the Section Editors, Room 237, Mallory Hall.
- 4:30 P.M. — Regimental Parade, Parade Ground.
- 5:00 P.M. — Senior Academy Conference and General Meeting; Room 111, Mallory Hall.
- 7:30 P.M. to 8:30 P.M. — Business meeting, Junior Academy of Science; Auditorium, Preston Library.

8:30 P.M. — General Electric "House of Magic" for Junior Academy members and guests; Jackson Memorial Hall.

FRIDAY, MAY 8

8:00 A.M. to 6:00 P.M. — Registration; Room 354, Mallory Hall.

9:00 A.M. — Section Meetings: Agricultural Sciences, Room 234, Mallory Hall; Astronomy, Mathematics, Physics, Room 111, Mallory Hall; Bacteriology, Room 44, Mallory Hall; Biology, Room 147, Mallory Hall; Chemistry, Room 102, Maury-Brooke Hall; Education, Room 454, Mallory Hall; Engineering, Room 105, Nichols Engineering Hall; Geology, Room 249, Mallory Hall; Medical Science, Room 442, Mallory Hall; Psychology, Room 18, Scott-Shipp Hall; Science Teachers, Room 252, Mallory Hall; Statistics, Room 237, Mallory Hall.

10:30 A.M. — Presentation of awards, Junior Academy; student presentation of exhibits. Address by John C. Fisher, Metallurgy Research Department, General Electric Company, Auditorium, Preston Library.

12:30 P.M. — Group Luncheons.

2:00 P.M. — Section Meetings.

3:30 P.M. to 4:45 P.M. — Symposium "Resource Use Education", sponsored by Virginia Resources Use Education Council, Lecture, Old Science Hall. (See program of Section of Biology.)

4:30 P.M. to 6:00 P.M. — Superintendent's Reception for members and guests of the Academy; Alumni Hall.

7:30 P.M. — Business Meeting, Senior Academy, Room 147, Mallory Hall.

8:30 P.M. — Address by Professor Hubert N. Alyea, Frick Chemistry Laboratory, Princeton University, "ATOMIC ENERGY: WEAPON FOR PEACE."

SATURDAY, MAY 9

9:00 A.M. — Section Meetings.

10:00 A.M. — Academy Council Meetings; Room 631, Preston Library.

2:00 P.M. — Field trips.

Small group luncheons or dinners may be arranged by writing Colonel R. P. Carroll, Department of Biology, Virginia Military Institute, Lexington, Virginia.

Program of Virginia Junior Academy of Science

WEDNESDAY, MAY 6

- 3:00 P.M. to 8:00 P.M. — Registration for Junior Academy members,
participants in the Science Talent Search.
3:00 P.M. to 8:00 P.M. — Setting up Exhibits.

THURSDAY, MAY 7

- 8:00 A.M. to 6:00 P.M. — Registration for Juniors.
9:00 A.M. — Meeting of Science Exhibit Judges.
9:30 A.M. — Meeting of Chairman and Exhibitors.
10:00 A.M. to 12:30 P.M. — Finalists of Talent Search meet with Chair-
man and Interviewers.
10:00 A.M. to 12:30 P.M. — Judging of Science Exhibit Contests.
1:30 to 4:00 P.M. — Continuation of Interviews of Finalists.
1:30 to 4:00 P.M. — Continuation of Judging of Exhibit Contests.
3:00 P.M. — Meeting of the Talent Search Committee.
5:30 P.M. — Dinner meeting of Junior Academy Committee.
7:30 P.M. — Business meeting of the Junior Academy of Science.
8:30 P.M. — General Electric "House of Magic" Show.

FRIDAY, MAY 8

- 10:30 A.M. — Student Presentation of Selected Exhibits. Address by John C. Fisher, Metallurgy Research Department, General Electric Company. Presentation of Junior Academy Awards.
3:30 P.M. — (For those Juniors still in attendance) Symposium, "Re-
source Use Education", sponsored by Virginia Resources Use Education Council. (See program of Section of Biology.)
8:30 P.M. — (For those Juniors still in attendance). Address by Dr. Hubert N. Alyea, Frick Chemistry Laboratory, Princeton University, "ATOMIC ENERGY: WEAPON FOR PEACE".

Section of Agricultural Sciences

T. J. NUGENT, *Chairman*

H. MARSHALL CLARK, *Vice-Chairman*

RODNEY C. BERRY, *Secretary*

WESLEY P. JUDKINS, *Section Editor (1956)*

FRIDAY, MAY 8, 1953 — 9:00 A.M. — ROOM 234, MALLORY HALL

- 9:00 Announcements, Committee appointments, etc.
- 1. 9:15 Insecticides — Research.
D. E. Greenwood; *Virginia Truck Experiment Station*.
- 2. 9:45 Insecticides — Regulatory Laws.
J. Claggett Jones; *Virginia Department of Agriculture*.
- 3. 10:15 Control of Mites in Strawberries in Virginia.
R. N. Hofmaster and D. E. Greenwood; *Virginia Truck Experiment Station*.
- 4. 10:30 Effect of Variety on the Ascorbic Acid on Carotene Contents and on the Yield of Sweet Potatoes.
James F. Eheart, P. H. Massey, Jr. and R. W. Young; *Virginia Agricultural Experiment Station*.
- 5. 10:45 The Effect of Light, Soil pH, and Trace Elements on the Carotene, Thiamine and Riboflavin Contents of Turnip Greens.
P. H. Massey, Jr., James F. Eheart and R. W. Young; *Virginia Agricultural Experiment Station*.
- 6. 11:00 Trace Element Studies of Some Virginia Pasture Plants.
Nelson O. Price and W. N. Linkous; *Virginia Agricultural Experiment Station*.
- 7. 11:15 A Suggested Role for Agricultural Scientists in Mineral Prospecting.
Richard V. Dietrich; *Virginia Polytechnic Institute*.

FRIDAY, MAY 8, 1953 — 1:30 P.M.

- 8. 1:30 The Relationship Between Size and Efficiency of Feed Utilization in Beef Cattle.
James E. Grizzle; *Virginia Agricultural Experiment Station*.
- 9. 1:45 Silage Studies.
Paul M. Reaves and R. Emory Brubaker; *Virginia Agricultural Experiment Station*.

10. 2:00 Types Studies for Proving Bulls.
Paul M. Reaves and Max Lund; *Virginia Agricultural Experiment Station.*
11. 2:15 The Evaluation of Stress in Dairy Cattle.
G. C. Graf; *Virginia Agricultural Experiment Station.*
12. 2:30 A Study of New Modified Babcock Tests.
C. C. Flora and G. E. Fisher; *Virginia Agricultural Experiment Station.*
13. 2:45 Information Which Can be Obtained in a Short Time From Long-Time Cropping and Fertilizer Experiments.
Russell K. Stivers; *Virginia Agricultural Experiment Station.*
14. 3:00 A Picturesque Trip Through the Dismal Swamp of Virginia.
Elvin F. Henry; *Virginia Agricultural Experiment Station.*
- 3:15 Business Meeting.

Section of

Astronomy, Mathematics, and Physics

S. M. HEFLIN, *Chairman*

L. W. WEBB, JR., *Secretary*

I. G. FOSTER, *Section Editor (1956)*

FRIDAY, MAY 8, 1953 — 10:00 A.M. — ROOM 111, MALLORY HALL

1. 10:00 A New Theory of Convergence.
E. J. McShane; *University of Virginia.*
2. 10:15 On the Embedding of a Sequence of Closed Sets in a Sequence of Arcs.
B. J. Ball; *University of Virginia.*
3. 10:30 Inelastic Scattering of 2.5 Mev Neutrons.
R. E. Garrett, F. L. Hereford, and B. W. Sloope; *University of Virginia.*
4. 10:45 General Equation for Conics and Pseudoconics.
Richard E. Herron and D. S. Davis; *Virginia Polytechnic Institute.*
5. 11:00 Pictures in Polars.
J. L. Troutman, J. M. Reynolds, and D. S. Davis; *Virginia Polytechnic Institute.*
6. 11:15 Lens Aberrations — Demonstration and Experiment.
I. G. Foster; *Virginia Military Institute.*

7. 11:30 A Lecture or Undergraduate Laboratory Experiment Demonstrating Both Temperature Coefficient of Resistance and the Fourth Power Radiation Law.
M. E. Cruser and E. C. Stevenson; *University of Virginia.*
8. 11:45 The Energy Loss of Mu-mesons and Electrons in Sodium Iodide.
G. M. Snead and S. J. Stratis; *University of Virginia.*

FRIDAY, MAY 8, 1953 — 2:00 P.M.

- 2:00 Business Meeting.
9. 2:15 Teaching Physics as a Profession.
S. M. Heflin; *Virginia Military Institute.*
10. 2:30 Tensile Strength of Thin Metallic Films.
Harold S. Morton; *University of Virginia.*
11. 2:45 The Equilibrium Ultracentrifuge.
Andrew Robeson and Norman Snidow; *University of Virginia.*
12. 3:00 The Magnetic Suspension Balance.
Walter E. Lotz, Jr., *University of Virginia.*
13. 3:15 The Measurement of Magnetic Fields.
Robert T. Wagner; *University of Virginia.*
14. 3:30 Gyro-magnetic Ratios.
Glen S. Waterman, C. J. Davisson, and J. W. Beams; *University of Virginia.*

SATURDAY, MAY 9, 1953 — 9:00 A.M.

15. 9:00 Magnetic Suspension Circuits.
Joseph Swingle, *University of Virginia.*
16. 9:15 Double Ultracentrifuge Cell.
Henry M. Dixon and J. W. Beams; *University of Virginia.*
17. 9:30 Ferromagnetic Deflection of High Energy Electrons.
S. Berko and F. L. Hereford; *University of Virginia.*
18. 9:45 The Polarization of Annihilation Quanta and the Einstein, Podolsky, Rosen Experiment.
F. L. Hereford and S. Berko; *University of Virginia.*
19. 10:00 Some Proposed Experiments with Liquid Helium.
J. W. Beams; *University of Virginia.*
20. 10:15 A Simple Method for the Measurement of the Surface Temperature of Rapidly Rotating Bodies.
A. R. Kuhlthau and E. M. Foley; *University of Virginia.*
21. 10:30 Astrometric Orbit of Gamma Geminorum.
Harold L. Alden and V. Osvalds; *University of Virginia.*

22. 10:45 Population Groups among Stars of Spectral Type G.
A. N. Vyssotsky; *University of Virginia.*
23. 11:00 Effect of Contamination on Transmission and Reflection of Light by Thin Metal Films.
H. Y. Loh and Peter Cheo; *Department of Physics, Virginia Polytechnic Institute.*

Section of Bacteriology

W. FRENCH SKINNER, *Chairman*

P. ARNE HANSEN, *Vice-chairman*

H. J. WELSHIMER, *Secretary*

J. DOUGLAS REID, *Section Editor (1956)*

FRIDAY, MAY 8, 1953 — 10:00 A.M. — ROOM 434, MALLORY HALL

1. 10:00 The Use of Ovotran in Mite Infestations of Laboratory Animals.
James A. Hancock, Jr.; *Medical College of Virginia.*
2. 10:20 Action of Lysozyme on Several Cell Structures of *Bacillus megaterium*.
H. J. Welshimer; *Medical College of Virginia.*
3. 10:40 Cultivation of Leptospira in the Developing Chick Embryo.
Catherine M. Russell; *University of Virginia.*

FRIDAY, MAY 8, 1953 — 2:00 P.M.

4. 2:00 Business Meeting.
4. 2:30 Primary Isolation of Johne's Bacillus *Mycobacterium paratuberculosis* from Bovine Intestinal Mucosa.
Robert H. Miller and P. Arne Hansen; *Department of Bacteriology and Live Stock Sanitary Service Laboratory, University of Maryland, College Park.*
5. 2:50 A Comparison of the Original Lowenstein Medium Against the Lowenstein-Jensen Modification in the Culture of *M. tuberculosis*.
John W. Pond and Geraldine Paul; *Richmond City Health Department and University of Richmond.*
6. 3:10 The Use of 24 Hour Egg Counts in *Paragonimus westermani* Infestations.
Michael Potter; *University of Virginia.*

Section of Biology

H. G. M. JOPSON, *Chairman*

ZOE WELLS CARROLL BLACK, *Vice-Chairman*

VERA B. REMSBURG, *Secretary*

ROBERT T. BRUMFIELD, *Section Editor (1957)*

FRIDAY, MAY 8, 1953 — 9:00 A.M. — ROOM 147, MALLORY HALL

9:00 Announcements, Committee Reports.

1. 9:10 The Taxonomic Significance of Megagametogenesis in *Tiarella cordifolia* L.
John M. Herr, Jr; *Washington and Lee University*.
2. 9:25 Discovery of *Forsstroemia ohioense* in Virginia.
Paul M. Patterson; *Hollins College*.
3. 9:35 A Simple Demonstration of the Effect of Heterauxin on Plant Growth.
Robert T. Brumfield; *Longwood College*.
4. 9:45 The Sex Chromosomes of the Domestic Cat.
L. Husted, and George Walker; *University of Virginia*.
5. 10:00 A Study of the Cyclic Behavior of the Testis of *Cambarus longulus longulus* Girard With Notes on the Juvenile Males.
Vera B. Remsburg; *Longwood College*.
6. 10:15 Bernard Mikula's Collection of Mosses in Virginia.
Paul M. Patterson; *Hollins College*.
7. 10:25 Apparent Competition between Two Groups of Crayfishes in the Southeastern States.
Horton H. Hobbs, Jr.; *University of Virginia*.
8. 10:35 Observation on Testicular Behavior in the Crayfish, *Cambarus montanus acuminatus* Faxon.
Benjamin H. Word Jr.; *University of Virginia*.
- 11:00 Business Meeting.

FRIDAY, MAY 8 — 1:30 P.M.

9. 1:30 The Effect of Indole-3-Acetic Acid on Regeneration and Spore Germination in Mosses.
Suzanne Scollard; *Hollins College*.
10. 1:40 Aquatic Plant Life in Virginia.
A. B. Massey; *Virginia Polytechnic Institute*.
11. 1:55 The Nature of Rhabdites in *Stenostomum virginianum*.
E. W. Pullen; *University of Virginia*.

12. 2:05 The Spermatogenesis of Two Hematotaeniid Cestodes.
Lee T. Douglas; *Emory and Henry College*.
 13. 2:20 Notes on the Occurrence of *Neoechinorhyncus cylindratus* in Fishes of Westhampton Lake.
Harry L. Holloway, Jr.; *University of Virginia*.
 14. 2:30 Curvature in Timothy Roots Induced by Ultraviolet Radiation.
Robert T. Brumfield; *Longwood College*.
- 3:30 Symposium on Resource-Use Education. OLD SCIENCE HALL.
Sponsored by the Resource-Use Education Committee of the Virginia Academy of Science.

MODERATOR: Alfred L. Wingo, *State Board of Education*.

PANEL: (Experts representing all of the resource agencies)
Prospective Participants:

1. I. T. Quinn, *Executive Director, Commission of Game and Inland Fisheries, Richmond, Va.*
2. S. W. Bondurant, *State Conservationist, Richmond, Va.*
3. George W. Dean, *State Forester, Va. Forest Service, Department of Conservation and Development, Charlottesville, Va.*
4. P. H. DeHart, *Assistant Director, Extension Service, V. P. I., Blacksburg, Va.*
5. J. L. McHugh, *Director, Virginia Fisheries Laboratory, Gloucester Point, Va.*
6. A. H. Anderson, *George Washington National Forest, Federal Building, Harrisonburg, Va.*
7. Charles Marsh, *William and Mary College, Williamsburg, Va.*
8. Ross H. Walker, *Mechanicsville, Va.*
9. Geo. W. Jeffers, *Biology Department, Longwood State Teachers College, Farmville, Va.*
10. Mrs. Elmira C. Maurice, *1208 W. 45 St., Richmond, Va.*

SATURDAY, MAY 9 — 8:30 A.M.

- 8:30 Field Trips.

Chemistry Section

HENRY LEIDHEISER, JR., *Chairman*

ROBERT C. KRUG, *Secretary*

CARL J. LIKES, *Section Editor*

FRIDAY, MAY 8 — 9:00 A.M. — ROOM 102, MAURY-BROOKE HALL

- 9:00 Introductory Remarks of the Chairman.
1. 9:15 The Phase Transformation of Cobalt as Observed on Single Crystals.
Victor J. Kehrer, Jr. and Henry Leidheiser, Jr.; *Virginia Institute for Scientific Research*.
2. 9:30 Copper Chelates of Some β -Diketones.
Connie Cole and Helen L. Whidden; *Randolph-Macon Woman's College*.
3. 9:45 An Investigation of the β -Amylase of Sweet Potatoes.
Camilla Floyd and Laura Bliss; *Randolph-Macon Woman's College*.
4. 10:00 Chromatography in Quantitative Analytical Work.
Margaret Fitzgerald and Helen L. Whidden; *Randolph-Macon Woman's College*.
5. 10:15 A Microcoulometric Method for the Measurement of the Relative Adsorption of Organic Substances on the Hydrogen Electrode.
Thomas C. Franklin and Ray Sothern; *University of Richmond*.
6. 10:30 The Preparation of Some 9-(Dimethylphenyl)-1, 2-Benzanthracenes.
Frank A. Vingiello and Alexej Borkovec; *Virginia Polytechnic Institute*.
7. 10:45 Mass Spectrometer Analysis of UO_2F_2 in UF_4 .
Russell Baldock, John R. Sites, L. O. Gilpatrick and Howard E. Carr; *Oak Ridge National Laboratory, Oak Ridge, Tenn.*
8. 11:00 The Use of an Anion Exchange Resin for the Isolation of Small Amounts of Zinc.
Richard M. Rush; *Pratt Trace Analysis Laboratory, University of Virginia*.
9. 11:10 Guest Lecturer. Topic to be announced.
- 12:10 Business Meeting.
- 12:20 Recess for Lunch.

FRIDAY, MAY 8 - 2:00

10. 1:50 Dithizone Extraction of Sub-Microgram Quantities of Cobalt in the Presence of Ammonia.
John F. Williams; *Pratt Trace Analysis Laboratory, University of Virginia.*
11. 2:00 Further Study on the Synthesis of Anilino-Methanol.
Joseph E. Sanders, Jr. and Edgar V. Russell; *Virginia Polytechnic Institute.*
12. 2:15 Tetrazolium Chlorides.
A. Garnett Richardson and J. Stanton Pierce; *University of Richmond.*
13. 2:25 A Study of Methods Used for the Determination of Rare Earth Elements in Substances Containing a High Concentration of Calcium and Phosphorus.
Roger K. Hoover and J. B. Lucas; *Virginia Polytechnic Institute.*
14. 2:40 Reactivity of Primary Alkyl Bromides with Thiocyanate Ion.
Thomas I. Crowell; *University of Virginia.*
15. 2:55 Solubilities of Some Inorganic Salts in Hydrogen Peroxide - Water Mixtures.
John D. Floyd and Paul M. Gross, Jr.; *University of Virginia.*
16. 3:10 Electrodeposition of Aluminum.
Nelson F. Murphy; *Virginia Polytechnic Institute.*
17. 3:25 The Electric Dipole Moments of Some N-Monosubstituted Benzamides.
James E. Worsham, Jr. and Marcus E. Hobbs; *Duke University, Durham, N. C.*
18. 3:55 Powder Formation During the Catalytic Reaction of Hydrogen and Oxygen on a Copper Single Crystal.
Bruce Wagner, Jr.; *University of Virginia.*
19. 4:15 A Proposed Mechanism of Catalytic Rearrangement of Metal Surfaces.
R. E. Cunningham; *University of Virginia.*
20. 4:30 Some New Color Reactions for Trace Quantities of Boron.
Robert L. Grob; *Pratt Trace Analysis Laboratory, University of Virginia.*
21. 4:40 Some New Sensitive Color Reactions of Magnesium.
Charles K. Mann; *Pratt Trace Analysis Laboratory, University of Virginia.*
- 4:50 Adjourn.

SATURDAY, MAY 9 - 9:00 A.M.

22. 9:00 Some Errors in a Standard Gravimetric Procedure for the Determination of Sulfur in an Iron Ore.
William E. Whitehurst and Edgar V. Russell; *Virginia Polytechnic Institute*.
23. 9:15 Charles' and Boyle's Law Apparatus for General Chemistry.
N. W. Allen and H. Ritchey; *Virginia Military Institute*.
24. 9:30 A Mathematical Analysis of Errors Involved in Reducing Sedimentation Constants to Water at 20° C.
Carl J. Likes; *Virginia Institute for Scientific Research*.
25. 9:45 The Preparation of Some 9-(Dimethylphenyl)-Anthracenes.
Frank A. Vingiello and Edward Kramer; *Virginia Polytechnic Institute*.
27. 10:00 Trimethylchlorosilane Derivatives of Organolithium Compounds.
F. M. Braswell and H. Ritchey; *Virginia Military Institute*.
28. 10:15 A New Colorimetric Method for the Determination of Uranium.
John H. Yoe, Fritz Will, III and Robert A. Black; *Pratt Trace Analysis Laboratory, University of Virginia*.
29. 10:25 Controlled Atmospheres in Spectrochemical Analysis.
Ralph E. Thiers; *Pratt Trace Analysis Laboratory, University of Virginia*.
30. 10:40 Henry's Law Constants for Gases at High Temperatures.
Ray C. Elton and D. S. Davis; *Virginia Polytechnic Institute*.
31. 10:50 The Absolute Entropy of the Chloride Ion.
Elmer S. McKee; *Washington and Lee University*.
32. 11:05 The Change of Entropy of the Chloride Ion with Concentration and Type of Cation.
Elmer S. McKee and Bentz B. Howard, Jr.; *Washington and Lee University*.
33. 11:20 Distillation of Sea Water.
William H. Gaines and Frank C. Vilbrandt; *Virginia Polytechnic Institute*.
34. 11:35 Scientific Vocations - A Survey of Promotional Materials.
Lowell V. Heisey; *Bridgewater College*.
35. 11:45 Evidence for cis - trans Configuration and Effective Conjugations of α -Phenylchalcones.
W. Bruce Black and Robert E. Lutz; *University of Virginia*.

36. 12:00 Ring-Chain Tautomerism of Substituted cis- β -Aroylacrylic Acids.
James W. Rinker, Collin L. Browne and Robert E. Lutz;
University of Virginia.
- 12:15 Adjourn.

Section of Education

JACK H. BOGER, *Chairman*

JOSEPH N. PAYNE, *Secretary*

FRANCIS G. LANKFORD, *Section Editor (1957)*

FRIDAY, MAY 8, 1953 — 9:00 A.M. — ROOM 454, MALLORY HALL

1. 9:00 A Study of Certain High School Graduates in Relation to their Elementary School Origins.
George G. Richards, Jr.; *Weller Baker School, Cambria.*
2. 9:30 Opportunities for Employment in Industry in the Norfolk Area of Virginia.
W. E. Lobeck; *Norfolk City Public Schools.*
3. 10:00 Some Principles, Procedures, and Problems Involved in Adjusting a College Curriculum to Meet the Challenge of Our Times.
Arnett G. Macklin; *Virginia State College.*
4. 10:30 A Study of the Academic Success of Virginia's College Freshmen Who Enrolled in the State's Institutions of Higher Learning During the Fall of 1948.
Alfred L. Wingo; *State Department of Education.*
5. 11:00 Academic Aptitude Testing of Freshmen at Longwood College.
M. Boyd Coyner; *Longwood College.*
6. 11:30 The Education of High School Science Teachers.
Percy H. Warren; *Madison College.*
7. 2:00 A Study of the Certification of Science Teachers in Virginia.
J. B. Chase; *University of Virginia.*
8. 2:30 Developing a Functional Program in Nursery School Education.
Alvia L. Bozeman; *Virginia State College.*
9. 3:00 Guidance Programs in Virginia Colleges.
W. D. Clague; *Bridgewater College.*
10. 3:30 Symposium on Resource-Use Education, sponsored by the Virginia Resource-Use Education Council.

Section of Engineering

VICTOR G. SZEBEHELY, *Chairman*

ROBERT W. TRUITT, *Secretary*

NELSON F. MURPHY, *Section Editor (1953)*

FRIDAY, MAY 8, 1953 — 9:00 A.M.

ROOM 105, NICHOLS ENGINEERING HALL

- 9:00 Announcements, Committee Reports.
1. 9:15 Engineering Aspects of Nuclear Energy.
J. M. Morgan, Jr.; *Civil Engineering Department, Virginia Military Institute.*
2. 9:45 Analogies Based Upon the Two-Dimensional Poisson's Equation.
James G. McGinley; *Applied Mechanics Department, Virginia Polytechnic Institute.*
3. 10:15 Compatibility of Highway Materials.
Phillip L. Melville; *Council of Highway Investigation and Research, University of Virginia.*
4. 10:45 Model and Prototype Behavior of Engineering Structures.
Dan H. Pletta; *Applied Mechanics Department, Virginia Polytechnic Institute.*

FRIDAY, MAY 8 — 2:00 P.M.

5. 2:00 A Survey of Various Methods of Analysis of Cantilever-Type Plates.
William A. Nash; *Navy Department, David Taylor Model Basin.*
6. 2:45 Design, Construction and Calibration of a Small Supersonic Wind Tunnel.
Fred W. Martin and Robert W. Truitt; *Aeronautical Engineering Department, Virginia Polytechnic Institute.*
7. 3:15 An Engineering Evaluation of the Continuity Method for Predicting the Form and Location of Detached Shock Waves for Two-Dimensional Flow.
Perry W. Hanson; *Applied Mechanics Department, Virginia Polytechnic Institute.*
8. 3:45 The Two-Dimensional Subsonic Compressible Flow Over a Joukowsky Airfoil.
Y. K. Pien and E. S. Cornette; *Applied Mechanics Department, Virginia Polytechnic Institute.*

9. 4:15 Aerodynamic Effects on a Body Immersed in a Non-Uniform Flow.
 Joseph L. Hendricks; *Applied Mechanics Department, Virginia Polytechnic Institute.*

Business Meeting at the close of the afternoon session.

SATURDAY, MAY 9, 1953 — 9:00 A.M.

10. 9:00 Line Coordinate Chart for the Viscosity of Aqueous Glycerin.
 Richard E. Herron and D. S. Davis; *Chemical Engineering Department, Virginia Polytechnic Institute.*
11. 9:30 The Effect of Operating Variables on Overhead Vapors and Residues from a Continuous Flash Distillation of Methanol-Water.
 Charles E. Littlejohn and Frank C. Vilbrandt; *Chemical Engineering Department, Virginia Polytechnic Institute.*
12. 10:00 Design, Construction and Operation of a Continuous Pilot Plant Hypersorption Unit for Vapor Phase Separation of CS₂ and H₂S.
 Seymour S. Stein and Frank C. Vilbrandt; *Chemical Engineering Department, Virginia Polytechnic Institute.*
13. 10:30 Operating and Design Variables in Continuous Liquid Thermal Diffusion.
 C. Leo Kingrea and Frank C. Vilbrandt; *Chemical Engineering Department, Virginia Polytechnic Institute.*
14. 11:00 The Relation of Vessel Diameter to Several Properties of Fluidized Beds of Solid Particles.
 John E. Lastovica, Jr. and Fred W. Bull; *Chemical Engineering Department, Virginia Polytechnic Institute.*

Section of Geology

RAYMOND S. EDMUNDSON, *Chairman*

WAYNE E. MOORE, *Vice Chairman*

WILLIAM T. PARROTT, *Secretary*

BYRON N. COOPER, *Section Editor (1953)*

FRIDAY, MAY 8 — 9:00 A.M. — ROOM 249, MALLORY HALL

- 9:00 Announcement, Committee Reports.
1. 9:10 Carolina Bays of the Coastal Plain of Virginia.
 Allen Sinnott; *District Geologist Groundwater Branch, U.S. Geological Survey, Charlottesville.*

2. 9:15 New Concept of Appalachian Thrust Faults.
Wilbur A. Nelson; *University of Virginia.*
3. 9:25 The Influence of Meg. B-8 an East-West Zone of Crustal Mega-shearing.
B. Ashton Keith; *The Institute of Sciences, Washington, D. C.*
4. 9:40 The Stratigraphy of the Broadford Sandstone and Superjacent Marine Strata in Southwest Virginia.
Lynn Glover; *Virginia Polytechnic Institute.*
5. 9:55 Silurian Formations of Southwest Virginia.
Ralph L. Miller and Leonard D. Harris; *U. S. Geological Survey, Washington, D. C.*
6. 10:10 Evidence of Turbidity in the Lynchburg Formation.
Edwin O. Gooch; *Virginia Geological Survey, Charlottesville.*
7. 10:25 Mineralogical Studies of Sediments from Nottaway River, Virginia.
Alden M. Pitard, Daniel E. Popovich, William V. Trol linger, and Henry D. Wagener; *Washington and Lee University.* (Presented by Alden M. Pitard.)
8. 10:35 Summary of Stratigraphy of Virginia Coastal Plain.
D. J. Cederstrom; *United States Geological Survey, Charlottesville.*
9. 10:55 An Occurrence of Oolitic Chert in Rockbridge County, Virginia.
Perrin Walker; *University of Virginia.* (Introduced by R. S. Edmundson.)
10. 11:00 Residual Sands and Erosion Surfaces of Western Virginia.
W. D. Lowry; *Virginia Polytechnic Institute.*
11. 11:10 Mineralogical Studies of Sediments from Smith River.
Raymond F. Bee, Jefferson R. Kean, II, and George M. Young, *Washington and Lee University.* (Presented by George M. Young.)
12. 12:20 Lithologic Variations in the Beekmantown along Cub Run, Page County, Virginia.
Robert M. Cordova and George S. Meadors; *University of Virginia.* (Presented by George S. Meadors.) (Introduced by R. S. Edmundson.)
13. 11:30 Early Paleozoic Structure in Southwestern Virginia.
Wayne E. Moore; *Virginia Polytechnic Institute.*
- 11:40 Announcements — Adjourn for Lunch.

FRIDAY, MAY 8 — 1:30 P.M.

14. 1:30 Mineralogical Studies of Meherrin River, Virginia.
Ehrick K. Haight, James L. Hinkle, James C. Rich, and
Jack A. Sites; *Washington and Lee University*. (Presented
by James L. Hinkle.)
15. 1:40 Mineralogy of the Clay Fraction of some Piedmont Soils.
James L. Eades; *Council of Highway Research and Investi-
gation, University of Virginia*.
16. 1:50 Paragenesis of Mineralization in the Climax Molybdenum
Deposit Colorado.
Charles E. Sears, Jr.; *Virginia Polytechnic Institute*.
17. 2:05 Geologic Section Across Western Floyd County, Virginia.
Richard V. Dietrick; *Virginia Polytechnic Institute*.
18. 2:20 Geology of the Iron Deposits at the Riverside Mine Near
Alvarado, Washington County, Virginia.
Byron N. Cooper and William E. Diggs; *Virginia Polytech-
nic Institute*. (Presented by William E. Diggs.)
19. 2:40 Trilobites from the Lower Champlainian Formations in the
Appalachian Valley.
Byron N. Cooper; *Virginia Polytechnic Institute*.
20. 2:55 Outline of the Geology of Poor Mountain, Roanoke and Floyd
Counties, Virginia.
T. E. Shufflebarger; *Virginia Polytechnic Institute*.
21. 3:10 Subsurface Reconnaissance by the Electrical Resistivity Meth-
od.
John P. Meador; *Virginia Department of Highways, Rich-
mond*.
21. 3:25 Some Current Activities and Projects of the State Geological
Survey.
William McGill; *Virginia Geological Survey*.
- 3:40 Business Meeting.

SATURDAY, MAY 9 — 8:00 A.M.

- 8:00 A.M. Mineral Collecting Field Trip at Irish Creek and vicinity — Place of assembling and details of trip to be announced at the meeting.

Section of Medical Sciences

E. G. HUF, *Chairman*

D. R. H. GOURLEY, *Secretary*

WILLIAM BICKERS, *Section Editor (1953)*

FRIDAY, MAY 8 — 10:30 A.M. — ROOM 442, MALLORY HALL

1. Effect of Insulin on the Oxygen Consumption of Intact Skeletal Muscle *in vitro*.
D. R. H. Gourley; *University of Virginia Medical School.*
2. The Influence of Low Protein Diet on the Distribution of Amino Acid Oxidases in Rats.
C. Hoch-Ligeti; *University of Virginia Medical School.*
3. Autonomic Responses from the Cortex of the Dog.
Herbert G. Langford; *Medical College of Virginia.*
4. The Role of Epinephrine in Ether Hyperglycemia.
D. T. Watts; *University of Virginia Medical School.*
5. Synthesis and Metabolism of N¹⁵-labeled Ethanolamine.
Lynn D. Abbott, Jr. and Jack D. Klingman; *Medical College of Virginia.*
6. The Ionization Constants of Thyroxine and Related Compounds.
C. L. Gemmill; *University of Virginia Medical School.*
7. Effects of ATP Complexes on P³² Uptake by Rabbit Erythrocytes.
H. Jonas; *University of Virginia Medical School.*
8. Effect of the Intravenous Administration of Paritol-C on the Serum Lipids of Hypercholesterolemic Rabbits.
J. C. Forbes and Olga Pettersson; *Medical College of Virginia.*
9. A Histochemical Study of the Lipids of the Corpus Luteum of Pregnancy in the Water Snake, *Natrix sipedon sipedon*.
D. E. Bragdon; *University of Virginia Medical School.*
10. Effect of the Repeated Administration of Alcohol on Guinea Pigs on a Scorbutogenic Diet.
J. C. Forbes and G. M. Duncan; *Medical College of Virginia and Division of Alcohol Studies and Rehabilitation, Department of Health, Commonwealth of Virginia, Richmond.*
11. The Possible Role of Psychological Factors in Causalgea.
Murray G. Mitts; *Medical College of Virginia.*

Section of Psychology

S. B. WILLIAMS, *Chairman*

L. S. REID, *Secretary-Treasurer*

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RICHARD H. HENNEMAN, *Section Editor (1954)*

FRIDAY, MAY 8 — 9:00 A.M. — ROOM 18, SCOTT-SHIPP HALL

1. 9:00 The Relative Effectiveness of Auditory and Visual Messages under Conditions of Noise.
James G. Holland; *University of Virginia.*
2. 9:15 The Course of Cutaneous Adaptation to Audio-frequency Current.
Andrew W. Gottschall; *University of Virginia.*
3. 9:30 Stability of Color Preference.
Walter A. Woods; *Richmond Professional Institute.*
4. 9:45 Nonreinforced Training in the T-maze.
Melvin Frietag; *University of Virginia.*
5. 10:00 An Experimental Test of the Estes Versus the Bush and Mostellar Theories of Learning.
Beth Forester and Burton P. Wolin; *College of William and Mary.*
- 10:15 Fifteen Minute Intermission . . .
6. 10:30 The Use of Continuous Addition Technique in Psychological Diagnosis.
V. J. Bielianskas; *Richmond Professional Institute.*
7. 10:45 Serial Effects as a Function of Inter-stimulus Interval.
Willard F. Day; *University of Virginia.*
8. 11:00 The Development of Syllogistic Reasoning in Children Five Through Eleven Years of Age.
Charles A. Peachee, Jr.; *Central State Hospital.*
9. 11:15 Tactual Apparent Movement.
Raymond C. Bice; *University of Virginia.*
10. 11:30 Sweetness and Food Consumption.
William Wagman; *College of William and Mary.*
11. 11:45 A Study of Voice as Related to Personality Traits.
Cora Lynn Chaffee; *Richmond Professional Institute.*

FRIDAY, MAY 8 — 2:00 P.M.

- 2:00 Business Meeting of Psychology Section.

12. 3:15 Physical Dimensions Related to the Perception of Mechanical Vibration.
Carl E. Sherrick; *University of Virginia*.
13. 3:30 A Study of Anxiety in the Minnesota Multiphasic Personality Inventory.
William E. Cook; *Richmond Professional Institute*.
14. 3:45 A New Short-cut Method of Psychotherapy for Psychoses.
John A. Blake; *Central State Hospital*.

Section of Science Teachers

THOMAS H. CRISTIE, *Chairman*

CAROLINE GAMBRILL, *Chairman-Elect*

L. W. JARMAN, *Section Editor (1954)*

FRIDAY, MAY 8 — 9:00 A. M. — ROOM 252, MALLORY HALL

- 9:00 Appointment of Committees and Announcements.
1. 9:10 Embedding Biological Specimens in Plastics.
Howard H. Edgerton; *Carolina Biological Supply Company*.
2. 9:40 Preparation for College Chemistry.
W. G. Guy; *William and Mary College*.
3. 10:10 Atomic Energy in High School Science Courses.
C. E. Savage; *Augusta Military Academy*.
- 10:40 Election of Officers.
4. 10:55 Use Techniques in Elementary Science.
Madison College.
5. 11:25 Discussion on the Use of Plastics in Science Teaching.
Howard H. Edgerton; *Carolina Biological Supply Company*.
6. 11:50 Evaluation of the Program.

FRIDAY, MAY 8 — 3:30 P. M. — OLD SCIENCE HALL

- 3:30 Symposium on Research-Use Education.
Sponsored by the Virginia Resource-Use Education Council.

THE ANNUAL SUBSCRIPTION rate is \$3.00, and the cost of a single number, \$1.00. Reprints are available only if ordered when galley proof is returned. All orders except those involving exchanges should be addressed to Boyd Harshbarger, Virginia Polytechnic Institute, Blacksburg, Virginia. The University of Virginia Library has exclusive exchange arrangements, and communications relative to exchange should be addressed to The Librarian, Alderman Library, University of Virginia, Charlottesville, Virginia.

NOTICE TO CONTRIBUTORS

Contributions to the Journal should be addressed to Horton H. Hobbs, Jr., Miller School of Biology, University of Virginia, Charlottesville, Virginia. If any preliminary notes have been published on the subject which is submitted to the editors, a statement to that effect must accompany the manuscript.

Manuscripts must be submitted in triplicate, typewritten in double spacing on standard 8½" x 11" paper, with at least a one inch margin on all sides. Manuscripts are limited to seven pages, with the proviso that if additional pages are desired, the author may obtain them at cost.

Division of the manuscript into subheadings must follow a consistent plan, and be held to a minimum. It is desirable that a brief summary be included in all manuscripts.

Footnotes should be included in the body of the manuscript immediately following the reference, and set off by a dashed-line above and below the footnote content. Footnotes should be numbered consecutively from the beginning to the end of the manuscript.

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C O N T E N T S

	Pages
Recent Experiments on the Ferromagnetic Deflection of Mu-Mesons and Electrons—STEPHAN BERKO AND FRANK L. HEREFORD.....	101
Observations on the Life History of <i>Hesperocorixa interrupta</i> (Say)—MARVIN L. BOBB	111
Large Elastic Bending of Cantilevers with Hydrodynamic Load- ing—PHILLIP EISENBERG AND L. FOLGER WHICKER	116
Virginia Bryophytes Collected by Bernard Mikula—PAUL M. PATTERSON	125
Electron Microscopic Analysis of Iron Oxide Pigments— RALPH R. WRIGHT AND WILLIAM G. DECHANT	129
Additional Records of the Occurrence of the Freshwater Jellyfish, <i>Craspedacusta sowerbii</i> , in Virginia—HORTON H. HOBBS, JR. AND CHARLES H. PAGE	137
Justus Henry Cline	138
News and Notes	140

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THE VIRGINIA JOURNAL OF SCIENCE

VOL. 4, NEW SERIES

JULY, 1953

No. 3

Recent Experiments on the Ferromagnetic Deflection of Mu-Mesons and Electrons¹

STEPHAN BERKO AND FRANK L. HEREFORD

Department of Physics, University of Virginia

The magnitude of the effective magnetic field acting upon charged elementary particles traversing a ferromagnetic medium was first considered in connection with unsuccessful attempts to deflect cosmic rays in magnetized iron (Rossi, 1931; Mott-Smith, 1931). The problem can be formulated as follows: Given a beam of energetic, charged particles traversing magnetized iron, what is the effective field acting on the particles due to their interaction with the ferromagnetic spin-aligned electrons? This problem leads, as we shall see in the discussion of the theory to the following statement: Any experiment designed to determine the effective magnetic field acting on elementary particles inside a magnetized iron sheet can be thought of as a sensitive detecting device of possible short-range forces between the beam particle and the spin-aligned electrons.

Danforth and Swann (1936) succeeded in first detecting a more or less qualitative magnetic scattering of cosmic rays, and found the effective field to be smaller than the macroscopically defined flux density B . Their approximate computations, however, lack relevant data on the nature of energetic cosmic rays (mesons), and they assume that high energy electrons are responsible for the main cosmic ray flux. Since 1944 several experiments (Bernardini, *et al.*, 1945; Rasetti, 1944) led to the result that for Mu-mesons the effective field is of the order of B . All these experiments were performed by studying the counting rate change in a GM telescope, having a block of magnetized iron between its counters. In all their interpretations, multiple scattering in iron played an appreciable role for which theoretical corrections had to be made. The only existing experiment on electrons deflected in magnetized iron was that of L. Alvarez (1934) who used 2.5 Mev electrons and photographic plates for detection. His results show, at best, the effective field to be much smaller than the classical B . In the light of the more recent theory, however, these results seem doubtful, mainly due to the way multiple scattering effects were corrected (Private communication from Professor Alvarez).

¹ Sponsored by the Office of Ordnance Research, U. S. Army.

Editor's Note: For a detailed paper, based on part of the research reported here, presented at the Annual Meeting of the Academy, May 1953, Messrs. Berko and Hereford received the *J. Shelton Horsley Award*. This award is made annually in recognition of the "most highly meritorious paper" presented at the Annual Meeting.

The question was first discussed from the theoretical point of view by von Weizsaecker (1933) on the grounds of the (then) new Dirac quantum theory of the electron. W. F. G. Swann (1936) raised some important objections against the supposition that the effective field has to be necessarily equal to B . These objections were, however, grounded on purely classical considerations.

The most complete theoretical investigation of the problem was carried through by Wannier (1947), using quantum-mechanical computations. He essentially substantiated some of the objections raised by Swann and pointed out the strong influence of possible short-range forces between beam particles and spin-aligned electrons on the final experimentally observed effective magnetic field.

In the following paragraph we shall briefly sum up the essential features of this theory.

THEORETICAL CONSIDERATIONS

Before discussing the theory of the problem to be investigated we will define what we mean by the effective magnetic field acting on a charged particle inside the ferromagnet. The definition is, by necessity, an operational one, relating to a certain experimental process. Given a charged particle with charge e and velocity v traversing an iron foil of thickness x . The particle undergoes a deflection away from its original direction due to the magnetization of the iron foil. This final deflection can be attributed to an *average* Lorentz force acting on the particle along its path through the iron, due to an "average magnetic field" b_{eff} connected by the formula

$$\bar{F}_{av} = C(\bar{v} \times \bar{b}_{\text{eff}}) \quad (1)$$

where C takes care of the respective units.

Next to this definition of the effective field we have that of the classical macroscopic electrodynamics, leading to the flux density B . For our purpose the best operational definition of B is through the usual experimental process of measuring the flux density prevailing inside the ferromagnet: A pickup coil is wound around the iron and connected to a ballistic galvanometer. One measures the total charge passing through it due to a reversal of magnetized current. This leads through the known formulas and the Faraday Law to the quantity $2B$. The difference in the definitions of b_{eff} and B is obvious. The coil used in the experiment to measure B automatically averages over the contributions of all elementary dipoles of the magnet leading to a true average flux per unit area. Since the elementary dipoles in the magnet are of microscopic nature (electron-spins) the particle sees along its path, passing through the ferromagnet, large variations in the magnetization (even negative directions of magnetization within small volumes surrounding the spin-aligned electron). The deflection of the particles will have to be analyzed by computing essentially the average *along* the path of the particle inside the ferromagnet.

The question then is reduced to the following: What are the conditions that lead to $b_{\text{eff}} = B$, and what effects would be able to change this result, should the conditions be not satisfied? This question can be answered only after a certain ferromagnetic model is accepted. It is known that ferromagnetism is due to the spin-alignment of 2 of the 26 iron electrons (the 3 d electrons). The "elementary" dipoles which contribute to the magnetization of the specimen are therefore the magnetic moments of these spin-aligned electrons. In order to investigate the nature of b_{eff} for this model, the question arose as to the "true nature" of the magnetic dipole of a Dirac electron. Von Weizsaecker (1933) showed that the Dirac electron behaves from the point of view of its magnetic moment like an elementary current loop of dimensions of the order of h/mc — the Compton wave length.

W. F. G. Swann (1936) derived classically the effective field one would get if one would assume rigid "true dipole moments" as the elementary magnet instead of circulating currents. His final result is, that

b_{eff} would be at best equal to $\frac{B + H}{2}$, therefore approximately equal

to $B/2$. Should, however, the circulating dipoles be of current nature, and *should the beam particles be able to penetrate these currents*, (amounting to electron-beam particle interpenetrations) the effective field

would be equal to B . The change from $\frac{B + H}{2}$ to B is due therefore,

according to Swann, to such interpenetrations.

Wannier's (1947) computations using the quantum-mechanical point of view, follows essentially Swann's steps. He also found that close range interactions between the beam particle and the spin-aligned electrons enter decisively in the averaging process leading to $b_{\text{eff}} = B$. Only if each point along the path of the beam particle is given equal statistical weight in this average, allowing for several interpenetrations, will b_{eff} equal B . Should, however, forces exist capable of hindering or favoring such head-on collisions, b_{eff} could be smaller or *larger* than B , according to the repulsive or attractive nature of such possible forces. Wannier performed his computations by introducing a "coincidence probability"

$$p(r) = \frac{\text{chance of finding the electron at } r \\ \text{if beam particle is also at } r}{\text{chance of finding the electron at } r \\ \text{if beam particle is far away.}} \quad (2)$$

Letting h be the fictitious average field produced if all electronic dipoles were of "rigid" nature, the introduction of $p(r)$ leads to the following general theorem concerning b_{eff} :

$$b_{\text{eff}} - h = 4\pi \int_V p(r) \rho(r) M_a(r) dv \quad (3)$$

where $\rho(r) = \overline{X}(r) X(r)$

$X(r)$ being the psi function, (essentially taken to be a plane wave) of the incident beam particle, and $M_a(r)$ the so-called atomic magnetization at r (see Wannier, 1947).

Using this general theorem concerning b_{eff} Wannier computed the effect due to Coulomb forces. The final result can be expressed as

$$b_{\text{eff}} = H + 2\pi M(p+1) \quad (4)$$

$$\text{where } p = \frac{4\pi^2 Ze^2}{hv} \neq \left(1 - e^{-\frac{4\pi^2 Ze^2}{hv}}\right)$$

v being the velocity of the beam particle.

Due to the nature of the Coulomb forces one gets a deviation from $b_{\text{eff}} = B$ (or $p = 1$) only for beam velocities of non-relativistic order. At these velocities ($v < 5.10^6$ cm/sec), however, nuclear multiple scattering effects are so large as to make an experimental verification of equation 4 practically impossible.

Should, however, other short-range forces exist between the beam particle and spin-aligned electron, forces having their maximum effect within regions of the order of a Compton wave length, a measurement of b_{eff} would exhibit them through a deviation of b_{eff} from B . In view of the lack of clear cut experimental data on the problem, we have undertaken a thorough investigation employing for the incident particles both high energy Mu-mesons and electrons in independent experiments. The details of this work have been described elsewhere (Berko, 1952, 1953; and Berko and Hereford, (in press). In the following paragraphs emphasis will be placed on the results obtained and their bearing upon the problem at hand.

MU-MESON EXPERIMENT

The meson experiment utilized as a source of incident particles the vertically incident mu-meson component of cosmic radiation at Charlottesville (approximately sea level). Mu-mesons constitute approximately 80% of the total ionizing radiation, and their momentum distribution is well known from previous work. In the present experiment a vertical pencil of mesons was selected by a Geiger counter "telescope" consisting of counters A and B in Fig. I and allowed to fall upon a 15 cm. diameter soft iron core which was part of a closed magnetic circuit. Coincident discharges of counters A and B were recorded in coincidence with 12 similar Geiger counters placed 87.5 cm. below the iron core as shown.

The coincidence rate in each of the 12 channels was recorded with the iron core demagnetized and magnetized to saturation. In order to deter-

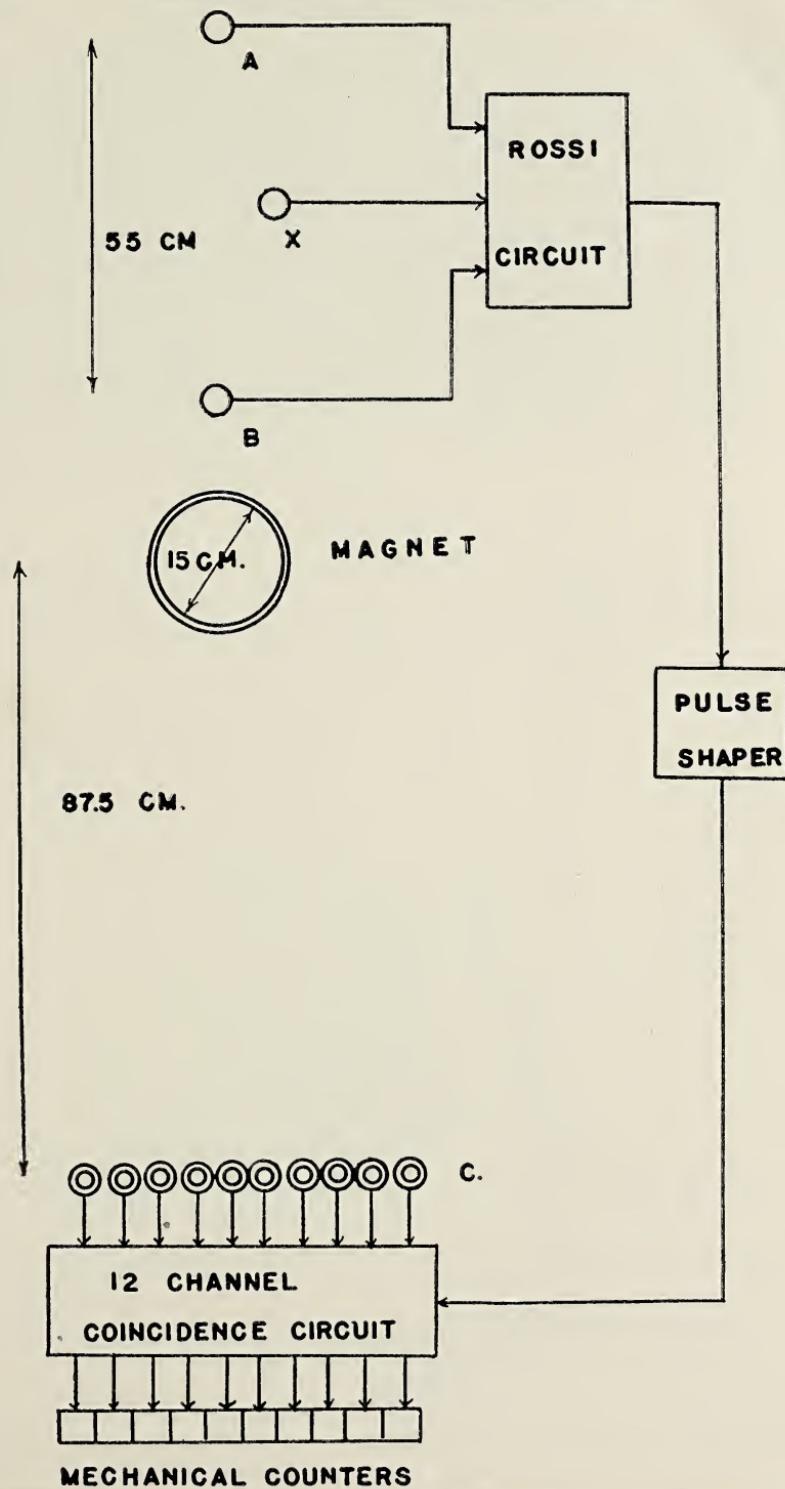


Figure 1

mine the influence of cosmic ray showers the out-of-line counter X was also included in a subsidiary experiment. The data are shown in Fig. 2 where the coincidence counting rate is plotted against the counter position. The significance of these curves is as follows. The "no field" curve simply represents the angular distribution of the emergent mesons due to multiple Coulomb scattering in the iron. The "field on" curve is the distribution into which the first curve diffuses due to the ferromagnetic deflection with the iron core saturated. In this experiment the results are not clear cut, because a continuous distribution of meson momenta and mesons of both positive and negative charge are present. The well known positive excess of the sea level meson distribution is shown by the greater extent to which deflections are to the left in Fig. 2. The principal advantage of this method over previous techniques is that the multi-

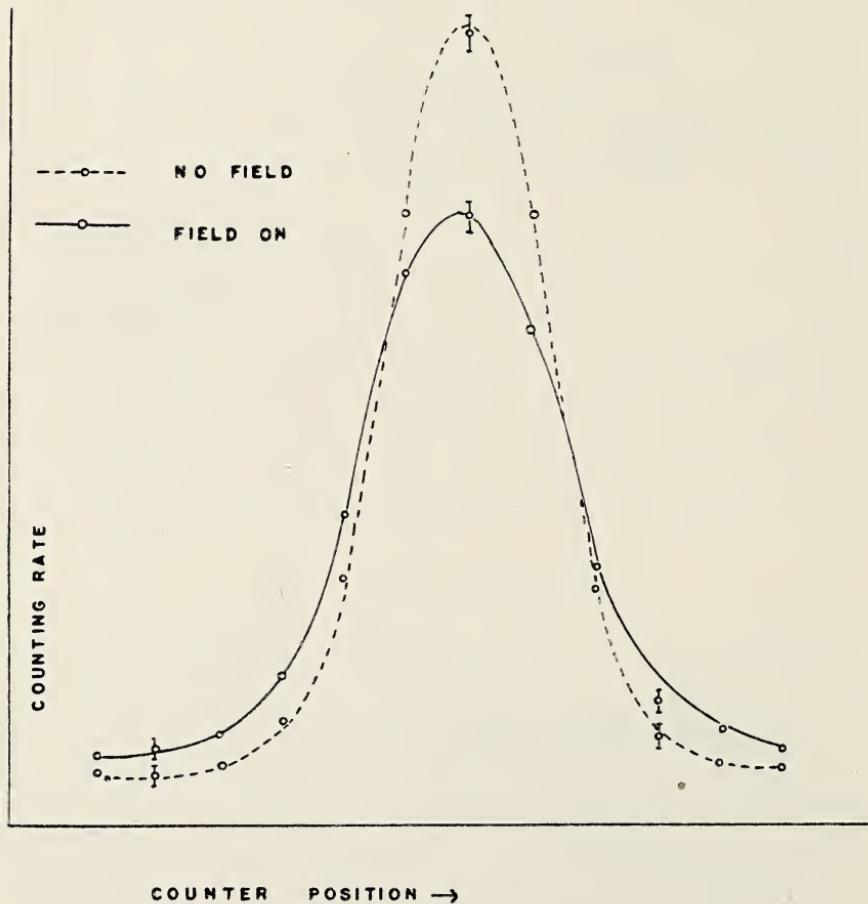


Figure 2

ple scattering effects are actually observed, whereas these effects were corrected for by means of calculations in previous experiments. Nevertheless, the analysis of the curves in Fig. 2 remains a somewhat tedious process. It has been performed by one of us (Berko, 1953); the result only will be stated here. The analysis involves the calculation of the contribution to each channel coincidence counting rate due to deflection of a meson incident with a given momentum which would be multiply-scattered at a given angle in the absence of a magnetic field. One must then integrate this result over the momentum distribution and the multiple-scattering angular distribution. Clearly this computation necessitates the assumption of a value for b_{eff} . It has been found that the assumption $b_{\text{eff}} = B$ (saturation value for soft iron) yields excellent agreement with the "field on" curve of Fig. 2. Hence this result indicates that for Mu-mesons the effective magnetic field is equal to the macroscopic flux density B to within the experimental errors (about 5%).

ELECTRON EXPERIMENT

In the case of an incident beam of electrons, one can happily avoid the complications inherent in the meson experiment due to different charges and the inhomogeneity of the beam momentum. To this end we have

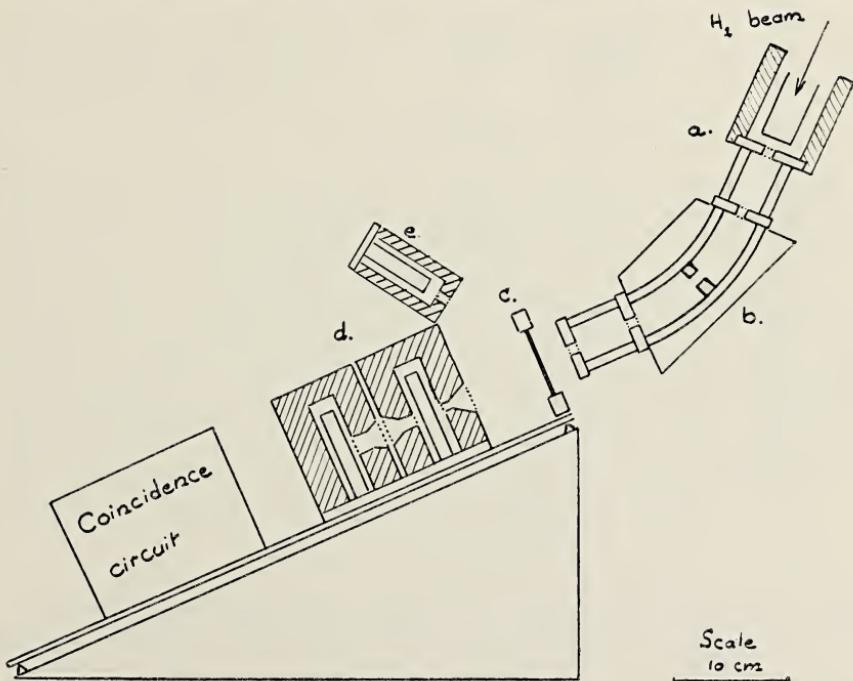


Figure 3

employed the electrons from the beta disintegration of B^{12} . This short lived isotope (.02 sec.) was continuously produced in the course of the measurements by the bombardment of B^{11} by deuterons ($B^{11} (d,p) B^{12}$). The B^{12} beta-ray spectrum has a maximum energy of 13.4 Mev and thus furnishes electrons of sufficiently high energy to make possible observation of the ferromagnetic deflection superposed on the (larger) multiple scattering deflection. Wannier's (1947) calculations indicate the necessity of higher energies than were used by Alvarez (1934).

The apparatus is shown schematically in Fig. 3. A target of elemental B^{11} was bombarded by 25 microamperes of 1 Mev deuterons from a Van de Graaff machine. The B^{12} beta rays were magnetically analysed to provide a monoenergetic beam of 8.8 Mev electrons. This beam impinged upon a 0.06 cm. sheet of Westinghouse Hyperco (saturating at about 20,000 Gauss) which was part of a closed magnetic circuit at (c). The scattered beam emerging from this sheet was observed by two thin

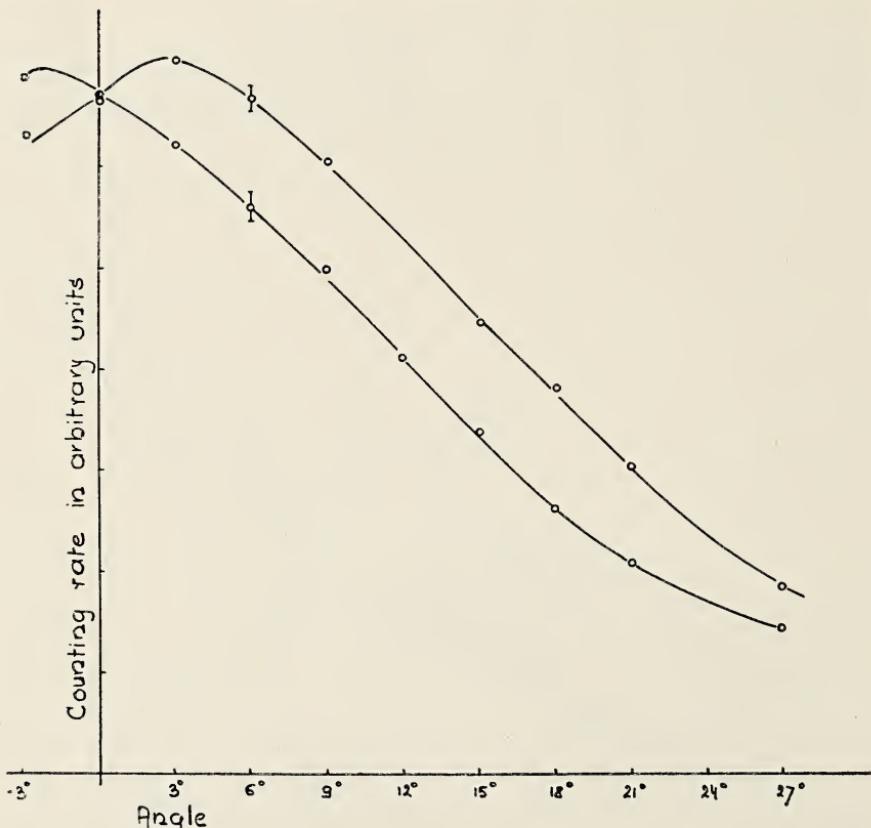


Figure 4

wall (25 mg/cm^2) Geiger counters enclosed in lead shields as shown. Coincidence counting rates were normalized with respect to a monitor counter at (e). The two coincidence counters were on a mobile mounting and could be rotated in a plane normal to the diagram about an axis through the Hyperco sheet. Thus, the multiple scattering angular distribution of the emerging electrons was observed with the magnetizing field both up and down. With this arrangement one expects a shifting of the entire scattering distribution due to the ferromagnetic deflection of the electrons. Fig. 4 shows one-half of the multiple scattering curves taken with the field up and down. Each curve is seen to be shifted (one to the right, one to the left). The magnitude of the angular shift is obviously twice the ferromagnetic deflection due to the field in one direction.

The analysis of these data is considerably more straightforward than that of the meson data. Using the known momentum of the incident electrons and the rate of loss of momentum in iron one can compute the value of b_{eff} from the observed angular deflection (Berko and Hereford, in press). By means of a pick-up coil and a ballistic galvanometer the value of the flux density B may also be measured. The results obtained are as follows:

$$b_{\text{eff}} = 18,400 \pm 400 \text{ Gauss}$$

$$B = 18,800 \pm 200 \text{ Gauss}$$

The agreement is considered to be entirely satisfactory in view of the various experimental errors.

CONCLUSIONS

We thus conclude in accordance with the theoretical discussion that no "short-range" forces exist between meson-electron and electron-electron pairs of sufficient magnitude to appreciably alter the Coulomb forces within distances of a Compton wave length.

An extremely interesting possibility is that of performing an experiment similar to those described herein with high energy positrons in an effort to detect possible short range forces between positron-electron pairs. Such forces are known to exist and are due to the virtual annihilation of a positron-electron pair followed by reabsorption of the photon pair. This interaction yields an observable shift in the energy levels of positronium (Deutsch and Dulit, 1951), but no calculations have been performed concerning their possible influence on ferromagnetic deflection.

ACKNOWLEDGMENTS

The authors are indebted to the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, especially to Dr. Norman Heydenburg, for the use of their Van de Graaff machine. The financial support of the Office of Ordnance Research, U. S. Army is also much appreciated.

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Observations on the Life History of *Hesperocorixa interrupta* (Say) (Hemiptera : Corixidae)¹

MARVIN L. BOBB

Virginia Agricultural Experimental Station, Charlottesville

Hesperocorixa interrupta (Say) is one of the larger members of the family Corixidae. Periodic collections made of *H. interrupta* from a pond known as the "Old Reservoir" near the University of Virginia during 1947, and notes taken on the species from 1946 to 1950 seem worthy of publication since no life history studies have been recorded for any of the species of this genus.

The "Old Reservoir" is a small, spring-fed pond with an abundance of submerged and emergent vegetation, and varies in depth from a few inches at the shoreline to about two feet. The bottom is covered with several inches of black mud and decaying leaves, and during the summer months supports a luxuriant growth of *Elodea*.

Distribution. — *Hesperocorixa interrupta* is widely distributed and has been recorded from Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Ohio, Indiana, Michigan, Wisconsin, Illinois, Arkansas, Nebraska, Missouri, and Quebec and Ontario, Canada.

In Virginia the species has previously been recorded by Hungerford (1948) from Church Bridge, Great Falls (5-16-20), Dogue Creek (7-6-?), Nelson County (7-27-28), and "Virginia".

The writer has collected *Hesperocorixa interrupta* from the following localities in Virginia: Albemarle Co. — three ponds near the University of Virginia; Alleghany Co. — Griffith (by R. L. Hoffman); Dinwiddie Co. — 14.7 miles south of Petersburg on U. S. Hwy. 1; Henrico Co. — 8.0 miles east of Byrd Airport at Richmond on U. S. Hwy. 60; Isle of Wight Co. — 2.8 miles east of Franklin on U. S. Hwy. 58; King William Co. — 10.2 miles southwest of Millers Tavern on U. S. Hwy. 360; Middlesex Co. — 5.3 miles north of Saluda on U. S. Hwy. 17; Surry Co. — 11.7 miles north of Bacons Castle on St. Hwy. 10.

Habitat and Associations. — This species inhabits ponds, streams, and swamps where individuals are found swimming, or resting on vegetation near the bottom.

Hesperocorixa interrupta has been collected in association with the following members of the family Corixidae: *Hesperocorixa nitida*, *Palmocorixa buenoi*, *P. gillettei*, *P. nana*, *Trichocorixa calva*, *T. macroceps*, *Sigara*

¹ Contribution from the Samuel Miller Biological Laboratories, University of Virginia.

signata, *S. modesta*, and *S. alternata*. The greatest number of associations were with *S. modesta*, *S. signata*, and *H. nitida*.

Life History. — The seasonal data given in table 1 give a fairly good picture of the life cycle. After mating in late summer the males die, and considerable numbers have been seen floating on the surface of the "Old Reservoir" pond in October and November. The adult females, and a few males, pass the winter on the bottom of the pond, but remain more or less active. In 1947 the first nymphs were found on May 15, but hatching had begun earlier as both first and second instar nymphs were found on that date. Probably the majority of the eggs are deposited during April, since dissection of females in early to mid-April contained many fully developed eggs, while in late April some of the females contained no eggs and their ovaries apparently were spent. The overwintering adults began dying in early May and by the latter part of that month very few were alive. During three years of observations the writer has seen but one overwintering adult later than June 1, this one being collected on June 11. Nymphs were first observed to transform into the adult stage between July 4 and July 11. Males and females occur in about equal numbers in July but some males begin to die after mid-August. There are five nymphal stages which require about two months for their total development. There is but one generation per year in Virginia.

Egg: — White when first deposited, darkening to yellow. Ovoid in shape with apex to the side of the principal longitudinal axis. Diameter 0.58 mm., length 0.68 mm. (Fig. 1).

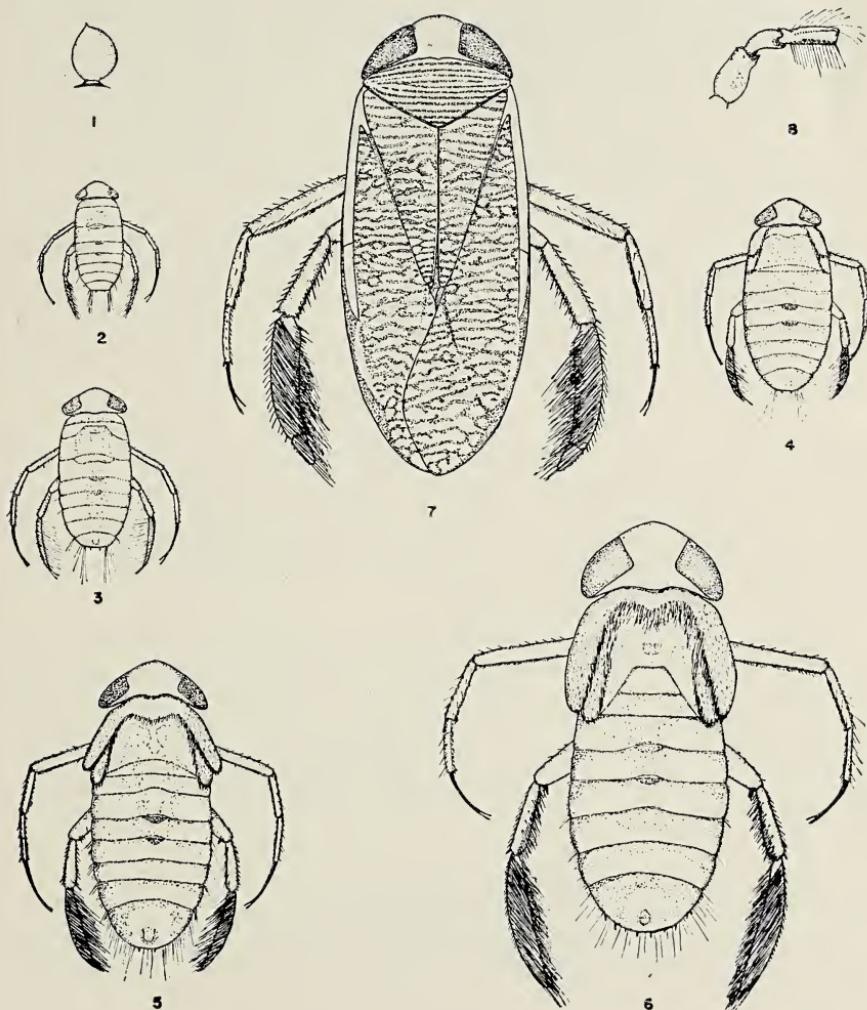
First instar. — General color a pale yellow, almost transparent, with slightly darker areas on thorax; eyes dark red. Body extremely flat with a group of long hairs at caudolateral angles of last segment. Antennae

TABLE 1.—Seasonal data on field collected individuals of *Hesperocorixa interrupta* (Say) from the "Old Reservoir" at the University of Virginia.²

Stage	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Adult male	1	2		1			34	10	12	7		1
Adult female	18	25	31	41	7	1	36	22	23	42	19	16
First instar					1	1						
Second instar						25	3					
Third instar					13	7	2					
Fourth instar						1	37	3				
Fifth instar							46	30	2			

² It is possible that a small number of the early instar nymphs recorded here are those of *H. nitida* since no characters were known to separate the small nymphs of the two species.

two-segmented. Tarsi of hind legs not conspicuously flattened and with relatively few hairs; two short terminal claws. Middle legs with tibiae and tarsi subequal in length, the latter terminating in two long claws, subequal to tibia and tarsus united. Tarsi one-segmented. No evidence of wing pads. Length 2.12 mm. (Fig. 2).



Hesperocorixa interrupta (Say)

Fig. 1, Egg. Figs. 2-6, First through fifth instars. Fig. 7, Adult male.
Fig. 8, Pala of male.

Second instar. — Color and structural characters similar to those of first instar. Abdomen with two reddish-brown dorsomedian spots. Tibiae of hind legs with a row of several long hairs, and tarsi with long hairs more numerous than in preceding instar. Faintest indication of developing wing pads. Length 2.97 mm. (Fig. 3).

Third instar. — General color remains a pale yellow but dorsally with brown bands on cephalic half of each abdominal segment, and thorax uniformly brown. Two reddish-brown dorsomedian spots caudad of third and fourth abdominal segments. Tibiae of middle legs more flattened with numerous swimming hairs; femora stouter and with more numerous hairs. Wing pads extend slightly caudad along lateral margin of thorax, covered with numerous fine, dark hairs, some of which extend across cephalic margin of thorax. Length 4.10 mm. (Fig. 4).

Fourth instar. — General color and markings as in third instar. Hind legs now well adapted for swimming; hind tarsi broad and flat with an abundance of long hairs; claws inconspicuous. Claws on middle legs proportionally longer as compared with length of tarsi. Wing pads extend to caudal margin of metathorax, prothoracic pair covered with very fine pile, both pairs with fine dark hairs along median margins and along cephalic margin of thorax. Length 5.94 mm. (Fig. 5).

Fifth instar. — Color pattern as in preceding instar, but general color slightly darker brown. Antennae two-segmented. Hind tarsi still one-segmented, with short claws. Claws of middle tarsi only about as long as tarsi. Legs stout and well adapted for swimming. Wind pads long, both pair reaching onto the second abdominal segment; thickly clothed with short hairs, and longer, darker hairs along median margin and covering prothorax. Length 8.40 mm. (Fig. 6).

Adult. — Head about one-third the length of pronotum. Pronotum with eight to ten broad dark transverse lines, somewhat irregular caudally. Hemelytra with broad dark bands on clavus in fairly regular series; dark bands of corium narrower and less regular. Lateral lobe of prothorax quadrate, almost straight across apex, broader than long. Pala of male with 28 to 30 pegs in a row along margin. (Fig. 2). Caudal margin of hind femur with about six stout spines on distal portion. Length 9.0 to 11.0 mm. (Fig. 7).

Summary. — Adults frequent lenitic situations throughout the year, but few specimens are to be found during May and June.

The eggs are laid during April and the overwintering adults (the population consisting largely of females at this time) are all dead by the middle of June.

The time required for a newly hatched first instar nymph to reach adulthood is approximately two months. Thus, most of the nymphs have emerged as adults by the end of July.

It seems probable that after the males have copulated the majority of them die, and very few adult males are present after the middle of Octo-

ber. Insofar as the writer is aware, the mass dying of the males in late summer is unique among the aquatic Hemiptera.

There is but one generation per year produced in central Virginia.

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Large Elastic Bending of Cantilevers with Hydrodynamic Loading

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There are a large number of applications relating to the towing of devices at sea or in a stream which require knowledge of the shape of and forces in the cable or strut used for towing. Much work has been done on the shape and tension of flexible cables (bending neglected) loaded by the forces arising during motion in a fluid (see, e.g., Landweber and Protter, 1944; Pode, 1951), and these can now be computed with considerable accuracy. No results are available, however, for the shape and stresses in elastic members used in such applications when the deflections are so large that linearized beam theory is no longer valid.

In this paper, the intention is to test the accuracy of a solution using the usual linearizing assumptions of elastic beam theory but making no initial approximations in the curvature term of the Bernoulli-Euler equation. Furthermore, it is assumed that the strut is not subject to vibration arising from interaction with its wake, so that the solution is valid only for those cases in which the natural frequencies of the strut are not near the wake frequencies. For the expressed purpose of the paper and for simplification of verifying experiments, it is sufficient to consider only a towed cantilever without the additional loading at the free end representing a towed body.¹

Derivation of the Elastic Equation.—The hydrodynamic loading is assumed to follow the "sine-squared law", i.e., the unit loading is $R \sin^2 \phi$ where R is the drag per unit length of beam when normal to the direction of motion and ϕ is the angle between the tangent to the beam and the direction of motion. Except for very small angles of inclination ($< 10^\circ$) to the stream, this result is well established by experimental evidence and supported by theoretical considerations (see, e.g., Glauert, 1934; Pode, 1950). Here,

$$R = \frac{1}{2} \rho U^2 d C_D$$

where

ρ is the mass density of the fluid,

U is the towing speed,

d is a characteristic section dimension of the strut, and

$C_D = C_D (R_d)$ is the drag coefficient (function of Reynolds number

$$R_d = \frac{Ud}{v}, \text{ where } v \text{ is the kinematic viscosity of the fluid.}$$

¹ The latter results will be included in a later report.

The tangential component of the hydrodynamic force has been found to be small in comparison with the normal force when the angle of inclination over most of the strut is reasonably large ($\geq 10^\circ - 15^\circ$), and will be neglected. An assumption that has not been directly verified is implicit in the present work. The sine-squared law has been verified for bars and stranded cables with no curvature; it is assumed here that this law applies locally everywhere on the deformed beam. The fact, however, that this has given accurate results in flexible cable problems is sufficient evidence, though indirect, of its validity.

The coordinate system used and the forces acting on an element of the strut of length ds are illustrated in Figures 1 and 2. The origin of coordinates is taken at the free end of the cantilever, $s = 0$, $\theta = \theta_o$. T , S , and M denote the axial force, shear force, and moment, resp. and W is the weight per unit length. Equilibrium requires, for the horizontal forces,

$$d(T \cos \theta) - d(S \sin \theta) = -(R \cos^2 \theta \sin \theta + W) ds$$

which, upon integration and evaluation of the integration constant at the origin, yields,

$$T \cos \theta - S \sin \theta = - R \int_0^s \cos^2 \theta \sin \theta ds + Ws + T_o \cos \theta_o - S_o \sin \theta_o \quad [1]$$

For the vertical forces,

$$d(T \sin \theta) + d(S \cos \theta) = R \cos^3 \theta ds$$

and, integrating,

$$T \sin \theta + S \cos \theta = R \int_0^s \cos^3 \theta ds + T_o \sin \theta_o + S_o \cos \theta_o \quad [2]$$

In summing moments, we assume that the contribution due to the change in axial force along the beam may be neglected in comparison with those of the weight and normal forces. This is, of course, equivalent to the usual assumption of small curvature of linearized beam theory; however, this has been used in similar problems with excellent results (Bickley, 1934).²

Thus

$$-S = \frac{dM}{ds} \quad [3]$$

² Bickley's results have also been verified experimentally by Mr. J. S. Brock of the David Taylor Model Basin.

Finally, to obtain the equation of the elastic curve, we take the Bernoulli-Euler result³

$$\frac{d\theta}{ds} = \frac{M}{EI}. \quad [4]$$

(since we are considering only beams that are long compared with any section dimension).

Eliminating T between [1] and [2] and combining the result with [3] and [4] to eliminate S gives,

$$\begin{aligned} -\frac{S}{R} = \frac{EI}{R} \frac{d^2\theta}{ds^2} &= \sin \theta \left\{ \right. \\ &\quad - \int_o^s \cos^2 \theta \sin \theta ds - \frac{W_s}{R} + \frac{T_o}{R} \cos \theta_o - \frac{S_o}{R} \sin \theta_o \left. \right\} \\ &\quad - \cos \theta \left\{ \right. \\ &\quad \left. \int_o^s \cos^3 \theta ds + \frac{T_o}{R} \sin \theta_o + \frac{S_o}{R} \cos \theta_o \right\} \end{aligned}$$

For the present purpose of testing the methods used in solving this equation, we take $T_o = S_o = M_o = 0$. This assumes that there is no additional loading at the free end even when towed as a cantilever. The flow around the free end, however, actually introduces a force T_o which will be largest when the free end is nearly normal to the stream direction, i.e., at low speeds, and will decrease (relative to R) as θ_o increases. As a result, this effect will be small compared with that of the normal forces and will be neglected.

$$\text{Put } \frac{EI}{R} = c^3, \quad \zeta = \frac{s}{c}, \quad \omega = \frac{W}{R}, \quad \xi = \frac{x}{c}, \quad \eta = \frac{y}{c} \quad [5]$$

The shape of the strut is then given by

$$\frac{d^2\theta}{d\xi^2} = \sin \theta \left\{ - \int_o^\xi \cos^2 \theta \sin \theta d\xi - \omega \xi \right\} - \cos \theta \int_o^\xi \cos^3 \theta d\xi \quad [6]$$

and

³ It has been shown by Seth (1934) that for large curvature the bending moment formula must be modified to include second order terms of the type, const. $\frac{h^2}{\rho^3}$, where h is the depth of the beam and ρ is the radius of curvature. An examination of the final results indicate that neglecting these terms is justified within the approximations of the present solution and within the elastic range of ordinary steels (i.e., before failure occurs) as indicated from observations during the experiments cited.

$$\begin{aligned}\xi &= \int_0^\zeta \cos \theta \, d\xi \\ \eta &= \int_0^\zeta \cos \theta \, d\xi\end{aligned}\quad [7]$$

Approximate Solution of the Elastic Equation.—An approximate solution of Equation [6] will be found by expansion in a Maclaurin's series⁴:

$$\theta(\zeta) = \theta(0) + \zeta \theta'(0) + \frac{\zeta^2}{2!} \theta''(0) + \dots \quad [8]$$

with the following remaining boundary conditions:

$$s = 0 : \theta = \theta_0, \quad M = 0$$

The first ten coefficients are:

$$\begin{aligned}\theta(0) &= \theta_0 \\ \theta^{(i)}(0) &= 0 \\ \theta^{(ii)}(0) &= 0 \\ \theta^{(iii)}(0) &= -\omega \sin \theta_0 - \cos^2 \theta_0 \\ \theta^{(iv)}(0) &= 0 \\ \theta^{(v)}(0) &= 0 \\ \theta^{(vi)}(0) &= 4\omega^2 \sin \theta_0 \cos \theta_0 + 2\omega \cos \theta_0 (2 \cos^2 \theta_0 - \sin^2 \theta_0) - 2 \sin \theta_0 \cos^3 \theta_0 \\ \theta^{(vii)}(0) &= 0 \\ \theta^{(viii)}(0) &= 0 \\ \theta^{(ix)}(0) &= 2\omega^3 \sin \theta_0 (35 \sin^2 \theta_0 - 14 \cos^2 \theta_0) \\ &\quad - \omega^2 (28 \cos^4 \theta_0 + 20 \sin^4 \theta_0 - 227 \sin^2 \theta_0 \cos^2 \theta_0) \\ &\quad + 65 \cos^6 \theta_0 - 24 \sin^2 \theta_0 \cos^4 \theta_0 \\ &\quad + 2\omega \sin \theta_0 \cos^2 \theta_0 (111 \cos^2 \theta_0 - 22 \sin^2 \theta_0)\end{aligned}\quad [9]$$

so that, to this degree of approximation

$$\theta = \theta_0 + \frac{\xi^3}{3!} \theta^{(iii)}(0) + \frac{\xi^6}{6!} \theta^{(vi)}(0) + \frac{\xi^9}{9!} \theta^{(ix)}(0) \quad [10]$$

⁴This procedure was also suggested by McLachlan (1950) for the solution of the heavy elastica. Bickley (1934) obtained results for the latter problem by numerical integration.

The shear is found from ⁵

$$\sigma = \frac{S}{CR} = \sin \theta \zeta \left\{ \int_0^\zeta \cos^2 \theta(a) \sin \theta(a) da + \omega \zeta \right\} \\ + \cos \theta \zeta \int_0^\zeta \cos^3 \theta(a) da \quad (11)$$

and the moments from ⁵

$$\mu = \frac{cM}{EI} = \left\{ \int_0^\zeta \sin \theta \gamma \left[\int_0^\gamma \cos^2 \theta(a) \sin \theta(a) da + \omega \zeta \right] d\zeta \right. \\ \left. + \int_0^\zeta \cos \theta \gamma \left[\int_0^\gamma \cos^3 \theta(a) da \right] d\zeta \right\} \quad (12)$$

To the degree of approximation used herein, the bending stress, obtained from the bending moment formula and the usual linearizing assumptions, is given by

$$\psi = \frac{S_{bend}}{E} \cdot \frac{s}{h} = \frac{1}{2} \mu \zeta \quad [13]$$

where S_{bend} is the bending stress and h is the depth of the beam in the plane of bending.

The effect of the last term in equation [10] is very small up to $\zeta \approx 3$ and $\theta_f = 0^\circ$ for all ω . At $\zeta \approx 5$, the last term approaches the same order as the other terms, but this is already beyond the range of ordinary applications. It is not immediately evident, however, that the terms of higher order are negligible or that the series so obtained are convergent. The form of the general term is not known, and convergence cannot be tested analytically for Equation [10]. As a result, experiments were conducted to determine the accuracy of the above results.

Comparison with Experimental Results.—The experiments were conducted with rods of circular section and lengths of 5, 9, and 10 feet with most data obtained with the latter length. Circular rods were chosen primarily because of the availability of drag coefficients C_D ; however, since data are available only for non-vibrating cylinders, it was possible to obtain data with rods only 1/8-inch and 1/4-inch in diameter. Larger rods were tested but the natural frequencies were in the range of vortex frequencies and large vibrations occurred so that these data could not be analyzed.

The towing arrangement is shown schematically in Figure 3. The test specimen was fastened to the lower end of a strut of ogival section which

⁵ The shears and moments are represented in these integral forms since greater overall accuracy will be obtained than by taking first and second derivatives of an approximating function with only a limited number of terms.

in turn was bolted to the towing girder of the carriage over the Deep Basin of the David Taylor Model Basin. The drag force was measured by the scale arrangement indicated. The fine deviation from equilibrium was indicated on tape on the revolving drum. Speeds were obtained by a chronograph arrangement also recording on the drum. The resolution in speed was 0.01 knot and in drag 0.005 pounds. Because of the tare drag of the ogival strut, however, the accuracy at the low speeds was much less than these values. For the data presented, it was estimated that the error in drag of the test specimen may be as high as $\pm 5\%$.

Since all tests were made with the rods initially vertical, i.e., $\theta_f = 0$, the measured drag is just the total shear. Thus, the total drag S is found from [11],

$$\sigma = \frac{S}{cR} = \int_0^\zeta \cos^3 \theta \, d\zeta \quad [14]$$

The experimental values were reduced using the following constants: $E = 29 \times 10^6$ pounds per square inch (obtained from tensile tests of several specimens), and $C_d = 1.2$. Because of the manner in which the towing tests were conducted, the rods were towed through fluid having a fairly high degree of residual turbulence induced during the previous passage. Thus, over the entire range of test Reynolds numbers, a constant value of $C_d = 1.2$ could be used (Schiller and Linke, 1933).

The theoretical values of σ were obtained by solving graphically for the value of θ_o vs. ζ corresponding to $\theta = 0$ for each value of ω , and then integrating equation [14] numerically.

The reduced experimental results are compared with the theoretical predictions in Figure 4. Considering the errors inherent in the assumptions made and in the experiments, the agreement is quite satisfactory. The angle θ_o corresponding to the highest value of ζ was about 63° .

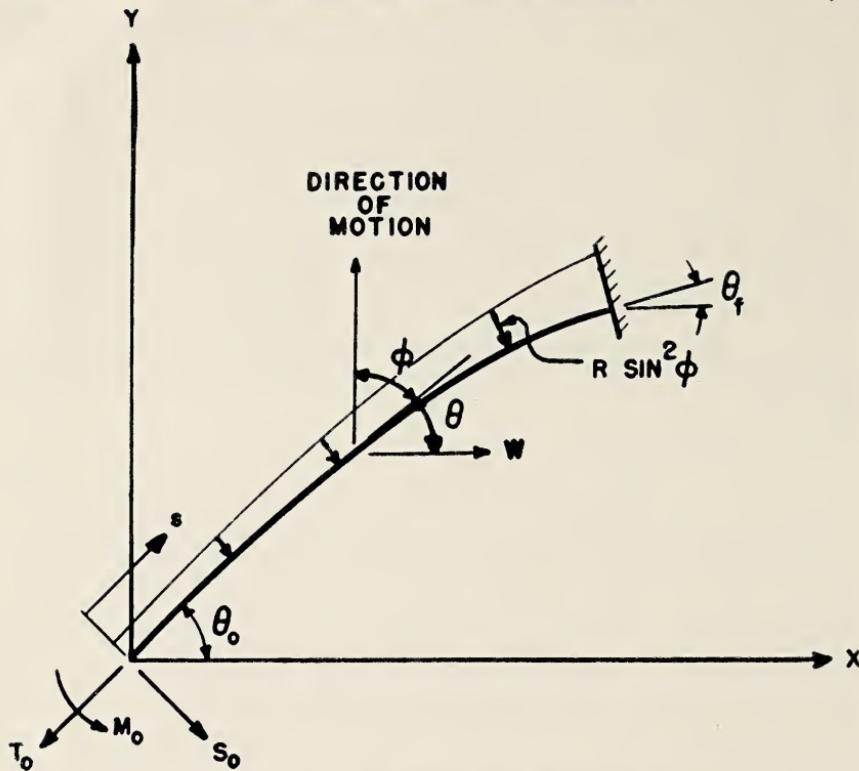


Figure 1.—Coordinate System and Assumed Loading.

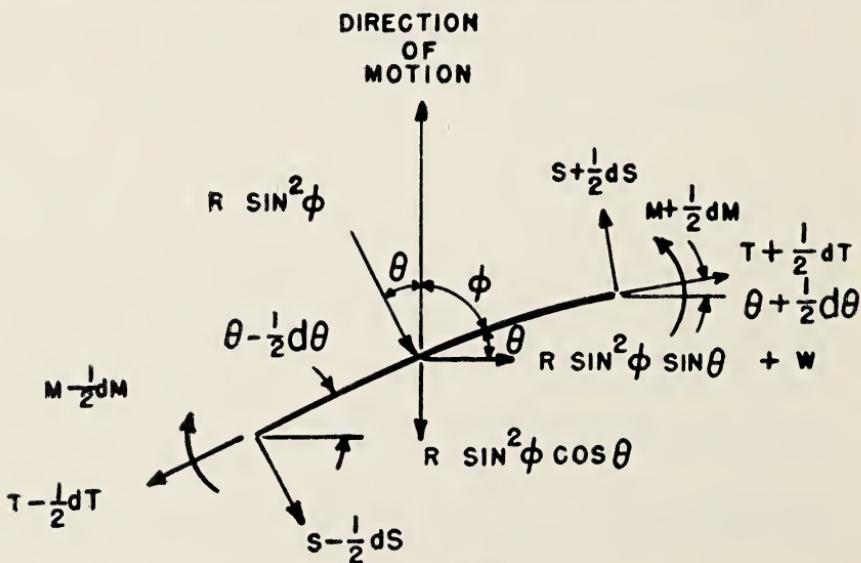


Figure 2.—Force Diagram.

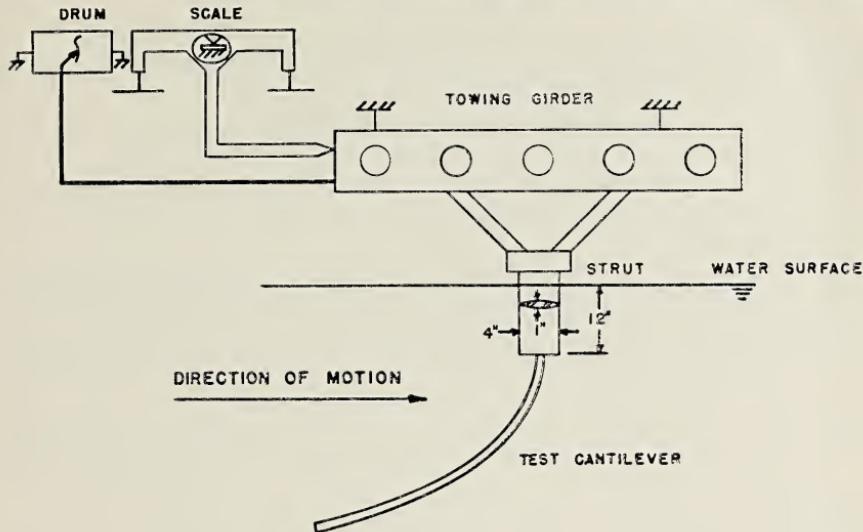


Figure 3.—Diagram of the Experimental Arrangement.

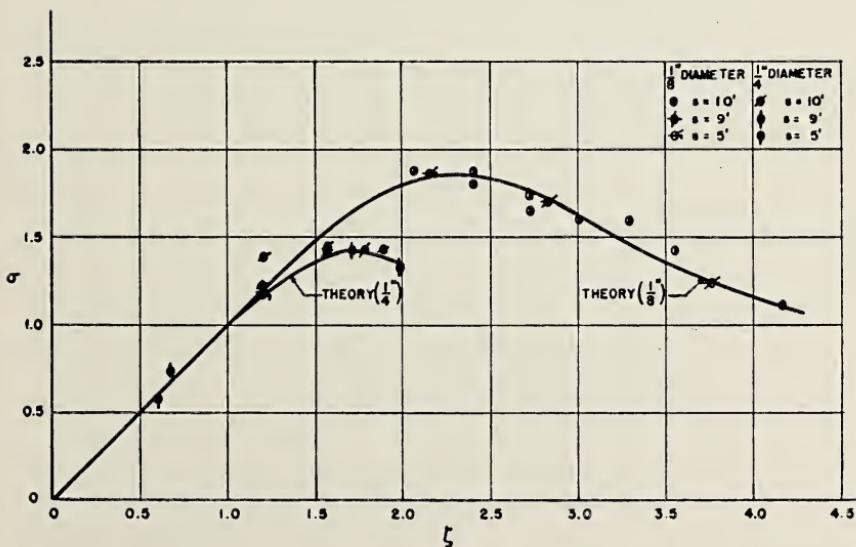


Figure 4.—Comparison between Theoretical and Experimental Results.

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Virginia Bryophytes Collected By Bernard Mikula

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During the summers of 1949 to 1950 Mr. Bernard Mikula, engaged in graduate studies at the College of William and Mary, did extensive field work in Virginia. While his interests were primarily in the seed plants, he made approximately 600 collections of bryophytes. As some of the collections were of mixed stands of bryophytes, the total collected is about 750. Some 450 of these are duplicates of 30 common species; however, approximately 130 different species and varieties are in these collections, including 17 species of hepatic.

Mr. Mikula has a good collection of peat mosses, and these are listed in full since our knowledge of their distribution is meager. Only the unusual hepatices and mosses are reported below. His collections were taken from 36 counties in all of the physiographic provinces of the State; however, the majority are from Virginia's southeastern Coastal Plains.¹

HEPATICS

Frullania Kunzei Lehm. & Lindb.

Norfolk, 9018 in part. Previous reports of this apparently rare southern species have been from Isle of Wight and Princess Anne Counties.

Leucolejeunea conchifolia Evans

Norfolk, 9018, in part; 9020 in part; and 9021-A in part. This is another apparently rare southern species which has been reported previously from Isle of Wight and Nansemond Counties.

PEAT MOSES

Sphagnum capillaceum (Weiss) Schrank.

9 collections in Greensville, King and Queen, Nansemond, and Southampton Counties.

Sphagnum compactum D. C.

Nansemond, 8502; Westmoreland, 5923.

Sphagnum cuspidatum Ehrh. var. *serrulatum* Schlieph.

Norfolk, 9017 in part. This is a new record for Virginia. The specimen is of an unusual growth form and I am indebted to Dr. H. L. Blomquist for its identification.

Sphagnum cuspidatum Ehrh. var. *Torreyi* (Sull.) Braith.

Nansemond, 8836, 8347, and 8401.

Sphagnum cyclophyllum Sull. & Lesq.

Norfolk, 9010 in part.

¹ Mr. Mikula's specimens are in the Herbarium of the College of William and Mary; certain of his duplicates are in my herbarium.

Sphagnum henryense Sull.

Nansemond, 8349 and 8407. This is apparently rare in the State. It has been reported previously in Princess Anne and New Kent Counties.

Sphagnum imbricatum Hornsch.

14 collections in Dinwiddie, James City, King and Queen, Nansemond, and Surry Counties.

Sphagnum imbricatum Hornsch. var. *affine* (R. & C.) Warnst.

5 collections in James City, King and Queen, Patrick, and Southampton Counties.

Sphagnum magellanicum Brid.

Greenville, 8704; Nansemond, 8337, and 8341. Previously reported from Caroline, Nansemond, and Princess Anne Counties.

Sphagnum palustre L.

19 collections in Greenville, James City, King and Queen, King William, Louisa, Nansemond, Norfolk, Southampton, Surry, and York.

Sphagnum recurvum Beauv.

13 collections in James City, King and Queen, King William, Nansemond, Norfolk, Richmond, Southampton, and Surry Counties.

Sphagnum strictum Sull.

Nansemond, 8348. The only previous collection is from Dinwiddie County.

Sphagnum subsecundum Nees

17 collections in Charles City, Dinwiddie, James City, Louisa, Nansemond, Norfolk, Shenandoah, Southampton, Westmoreland, and York Counties.

Sphagnum tenerum S. & L.

Nansemond, 8346 and 8414; Surry, 7621. Previously reported from Henrico and Nelson Counties.

MOSES

Atrichum crispum (James) Sull.

Nansemond, 8504. Previously reported from Caroline, Giles, and Stafford. This species is apparently uncommon.

Polytrichum commune Hedw. var. *perigoniale* (Mx.) B. S. G.

Charles City, 5580; Patrick, 6893. This is a new record for Virginia. My S. E.-336 from New Kent County also turns out to be this variety.

Ditrichum heteromalla (Hedw.) Schimp. var. *orthocarpa* (Hedw.) Paris

This was reported from Southampton County, Patterson (1951), but was not reported as a new record. Mikula's 8511 from Nansemond County is now the second record of this moss.

Tortula fragilis Tayl.

Lunenburg, 8193. It has been previously reported from Augusta and Giles Counties. This is its first report from the Piedmont.

Funaria flavicans Michx.

Mecklenburg, 8179, in part. An uncommon moss, previously recorded from Campbell, Henrico, Prince George, and Roanoke Counties.

Philonotis capillaris Lindb.

James City, 4647; Surry, 5540. The first report of this species in Virginia was that of Flowers (1935). Patterson (1951) in reporting the bryophytes collected by Bayard Long failed to report his No. 2611 in part from Prince George County which is this species. In 1952 Mr. R. L. Hoffman showed me a moss he had collected in the Dan River Gorge in Patrick County which also turned out to be this species.

Chamberlainia cyrtophylla (Kindb.) Grout.

Shenandoah, 5199. This is an infrequently collected moss; previous reports are from Albemarle, Giles, James City, and Roanoke Counties.

Drepanocladus aduncus (Hedw.) Warnst.

Frederick, 5099; Shenandoah, 5266. This is an unusual boreal moss which has been previously collected in Augusta, Botetourt, Giles, Roanoke, Rockbridge, and Smith Counties.

Rhytidium rugosum (Hedw.) Kindb.

Madison, 5442. This is an uncommon moss reported previously from Giles, Greene, and Page Counties. I have also collected it in Botetourt, (R-135, R-136, and R-671); and in Rockbridge, (R-836).

Helodium paludosum (Sull.) Aust.

Charles City, 4963, King and Queen, 5793 & 5937. An uncommon moss previously collected from Caroline and Charles City Counties.

Leskeia arenicola Best.

James City, 8223. This one has been reported previously from Prince George, Spotsylvania, and Sussex Counties.

Thuidium Allenii Austin

James City, 4879; New Kent, 8604. An uncommon species previously reported from Norfolk and Princess Anne Counties.

Fontinalis novae-angliae Sull. var. *cymbifolia* (Aust.) Welch

Greensville, 2825, in part. Mr. H. A. Gleason's No. 3077 from Nansemond County is this same variety. My appreciation is hereby expressed to Dr. Winona H. Welch who identified both of these collections. These are the first reports for Virginia since that of Rau & Hervey (1880).

Dichelyma capillaceum B. S. C.

Greensville, 2825, in part. Apparently a very rare moss in Virginia; previously reported from Dinwiddie County.

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Electron Microscopic Analysis of Iron Oxide Pigments

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The pigments studied in this investigation are commonly known as hydrated yellow iron oxide pigments. They are manufactured by a corrosion process which was originally covered by the patents of Penniman and Zoph.¹ One of the larger manufacturers of iron oxide pigments undertook a microscopic study of pigments in an effort to check present theories regarding particle size and to correlate particle size and shape with the quality of iron oxide pigment produced. Because of the smallness of the particles² involved, it was found impossible to make a satisfactory study of particle size and shape with a light microscope. At the suggestion of the manufacturer an electron microscopic study of samples of hydrated yellow iron oxide pigments made by two pigment manufacturers (hereafter referred to as Companies A and B) was undertaken.

LITERATURE REVIEW

Green in 1921 was the first investigator to describe requirements for completely satisfactory pigment mounts. Employing the technique of rubbing the pigment particles into an exceedingly thin layer with turpentine and mounting them in a soluble medium such as glycerol, he made fairly successful photomicrographs of several types of white lead pigments, zinc oxide pigments, and iron oxide pigments. Photomicrographs of these pigments taken at 1500 diameters are displayed in his paper. From his measurements, he found that the various types of iron oxide pigments analyzed varied from an average diameter of 0.44 to 0.58 micron.

It was later discovered that the technique of pigment mounting developed by Green had two serious disadvantages, i.e., some grinding of the large particles usually occurred and a certain amount of segregation invariably occurred. The second of these disadvantages was overcome by Haslam and Hall in 1930. They gathered all the pigment dispersed in turpentine in the center of the slide. Haslam and Hall not only developed a new technique for mounting paint pigments, but they also used ultraviolet light which enabled them to obtain a higher resolving power than had been used in pigment studies before. By use of a Zeiss ultraviolet microscope and employing a cadmium arc as the source of light (giving a wave length of 2,750 Angstrom units), and by enlargement of their photomicrographs, Haslam and Hall were able to get a total magnification of 3,860 diameters. Although they did not make photomicrographs

¹ Penniman and Zoph, U. S. Patents Nos. 1,327,061 and 1,368,748.

² The particle size was found in this investigation to be in the order of 0.5 micron.

of iron oxide pigments, they did make a study of three different types of zinc oxide pigments. They found the coarsest sample to have an average diameter of 0.603 micron and the finest sample to have an average diameter of 0.164 micron. They compared these values of particle size³ to values for the same sample using visible light as a source of illumination and found appreciable discrepancy in results. This fact would seem to indicate the inadequacy of the ordinary light microscope for determining pigment particle size.

Allen in 1942 described a method of pigment mounting for light photomicroscopy which was an improvement over the methods of Green, and Haslam and Hall. In brief, Allen's method consists of dispersing the dry pigment in high concentration in a suitable optically clear cement. This method makes possible the utilization of the high shearing forces created in the stiff viscous mixture and prevents grinding of the larger particles. The actual mount is then formed by dilution of the dispersion of high concentration already obtained. Employing this method, Allen made successful zinc oxide and iron oxide pigment mounts.

Fuller in 1943, with the aid of an electron microscope, made a crystallographic analysis of the characteristic shape of particles found in zinc oxide produced as a result of burning zinc vapor. He mounted and made successful electron micrographs of these particles at a magnification of 3,500 diameters.

Two methods for preparing a pigment dispersion for electron microscopy were described by O'Brien in 1945. The first method consists basically of wetting the pigment with distilled water and then dispersing it in a solution of cellulose acetate. The second method, which has the advantage of eliminating the possibility of mechanical or chemical damage which is common to the first method, utilizes an electrostatic dispersion apparatus. A complete description of the electrostatic dispersion apparatus used by O'Brien is given in his paper.

Brubaker in 1945 made a comparison of particle size of zinc oxide pigments as determined by light and electron microscopes. By making light and electron micrographs of identical fields, he concluded that the size and shape of particles could be determined much more accurately from electron micrographs.

After making optical and electron micrographs of many types of paint pigments, including zinc and iron oxide pigments, Tilleard and Smith in 1946 reached the following conclusions:

Because of its extremely high resolving power, the electron microscope offers considerable advantages over the optical microscope in the examination of the sizes and shapes of the ultimate particles of the finer pigments. Such information will not only assist in the study of the nature of these particles and the properties of the finished pigments but also, when obtained at stages in

³ It is customary in the paint industry to use the expression "particle size" when referring to diameters.

pigment production, should prove of value in studies of the development of pigmentary properties.

To the author's knowledge, Tilleard and Smith are the only investigators of particle size to point out possible pitfalls in electron micrographic analysis of pigments. They raise two important points to be kept in mind when interpreting electron micrographs of pigment particles.

1. The particles seen in the electron microscope may be only the smaller particles of the pigment. Large particles may in fact be present in the material, but these, particularly if their size is commensurate with the size of the whole field of the microscope, will frequently be neglected.
2. The quantity of material observed, even in traversing a large area of the field of the electron microscope, is very minute, and it is not justifiable to draw quantitative conclusions (*e.g., by counting particles*) except in special circumstances where it is known that the complete range of particle sizes is represented in the electron microscope field.

Tilleard and Smith also compare particle size and shape of a number of pigments commonly used in paints as determined by optical microscopy, electron microscopy, and absorption experiments.

INVESTIGATION

After a careful study of the problems involved, the following objectives were formulated: (1) to develop a technique for making electron micrographs of iron oxide paint pigments, and (2) to determine the gross structure and approximate particle size of the standard types of iron oxide paint pigments made by two different manufacturers of iron oxide pigments.

The first objective proved to be a major problem. In order for the specimen to be suitable for examination with an electron microscope, it is necessary that it not be opaque to an electron beam. The electron beam must pass through the specimen and cast its image on the screen. Non-opacity dictates the necessity of having extremely thin specimens and specimen mountings, and also that the specimen be of such a nature that it will transmit the electrons without being destroyed as a result of electron bombardment. The maximum thickness a specimen can possess is in the order of 0.2 micron.

Objects to be examined by an electron microscope and the technique devised for preparing them can be grouped into four categories: (1) suspensions of small particles; (2) thin section of larger objects; (3) surface films; and (4) surface replicas. The pigments to be studied were in powdered form and thus fall in the first category.

Suspensions of fine particles may be examined by placing them on a very thin membrane or incorporating them directly in the membrane. The

main problem involved is to perfect a technique for obtaining a membrane that will meet the necessary requirements.

There are several techniques and a number of materials which are suitable for fabricating membranes. The most common materials used to form such membranes are collodion, Formvar, and polystyrene in the plastic field, beryllium or aluminum in the light metal field, and silica in the oxide field. Plastic membranes are easier to handle and require less time to make but are more easily destroyed than are some of the others. Oxide films are heat and chemical resistant and more stable than plastic films. The light metal films show excellent stability and can be made extra thin without danger of destruction. It is customary to mount the membranes on screens about 2 mm. in diameter having 200 wires to the inch.

Collodion membranes are quickly and easily made and are satisfactory for mounting many types of specimens. They are prepared from a solution of USP collodion diluted with amyl acetate. The most common method of obtaining this film is to allow a few drops to spread over the surface of distilled water contained in a vessel of not less than ten inches in diameter. The thickness of the film depends upon the number of drops used. The film then requires two to three minutes for drying, after which several 200 mesh screens can be dropped on it. A clean glass slide is next pushed down over the screens and then brought up through the water so that the screens remain on the glass and covered by the collodion film.

Membranes other than collodion can be made in this way, providing the solvent used is not miscible with water. Formvar in ethylene dichloride can thus be used.

Another technique using plastic consists of coating a clean glass plate with a film which is then floated onto a distilled water surface for mounting on grids. The film may be produced on the slide by dipping or by "flowing" it on one side only. Formvar is particularly adaptable for this use. The film can be made to leave the glass and float on the water by starting it with a razor blade or scalpel. If it does not leave readily, breathing on the film may hasten its removal from the glass. The films, once they are water-borne, may be handled like the collodion films. Satisfactory Formvar films that will float freely from glass slides can be made only from fresh solutions.

After the membrane has been produced by one of the previously described methods, the next step is to place the particles to be observed on the surface of the film in such a way that they will adhere to it. It is also necessary that the particles be within one of the openings in the 200 mesh screen in order that they may be viewed on the microscope screen. If the suspension of particles is in distilled water, a drop of the solution may be applied to the film and the water then evaporated. This will allow the particles to adhere to the film and it is probable that some of them will be located in some of the openings in the screen.

In case of non-uniformity of particle distribution, there are several ways in which the problem can be overcome. If the material is in dry powder form, some of the particles can be mixed directly in the plastic and then the plastic handled as before, or the particles can be suspended in distilled water and sprayed on the film-covered screens with an atomizer.

While plastic films are satisfactory for the average electron microscope specimen, in general they possess an undesirable texture when used in conjunction with smaller specimens. For this reason, it is necessary to resort to a smoother film. Films in this category are those made from silica or one of the light metals.

Although many procedures for preparing specimens of pigment for electron microscopy were tried, only the most successful one will be described here.

This procedure is as follows: A film-forming solution was prepared by mixing 35 cc. of amyl acetate (USP) with a 5 cc. solution of collodion (USP). A large glass bowl (about 12 inches in diameter) was cleaned thoroughly and filled to the rim with distilled water. Next, a drop of the collodion solution was applied to the surface of the water and allowed to spread evenly. After two or three minutes, to allow for drying, several of the 200 mesh screens were dropped onto the film to which they adhered. A clean glass plate was then brought down over the screens. The collodion film on the water surface was thus pushed down, folded up around the bottom edge of the slide, and applied evenly on the surface of the glass. The screen disks then were located between the film and the glass. The excess water was drained and the film dried by means of a hot air blast from an electric drier. The glass slide containing the screens and film was then subjected to examination under a Bausch and Lomb vertical light microscope in an effort to ascertain the presence of a uniform collodion film on the screen disk. If a film was found to be present⁴ a drop of a dilute solution of the pigment sample in distilled water was placed on the screen and the water evaporated. When this screen was thoroughly dried, it was carefully removed from the glass slide and placed, film side down, in a brass specimen cup. The cup was then mounted on the specimen holder which was in turn placed in the electron microscope specimen chamber for viewing. If a satisfactory specimen was located in one of the screen openings, an electron micrograph was made of the specimen by means of the photographic attachment on the microscope.

The process was repeated many times with samples of pigment, manufactured by Companies A and B. A typical electron micrograph of iron oxide pigment No. 620 is displayed in Fig. 1a.

From a study of these electron micrographs, it was discovered that gross structures of the same color pigment manufactured by Companies A and B were essentially identical, *i.e.*, rod-like in form. Because of the conglomeration of particles, it was difficult to make accurate measurements of the particles. In order to separate to a greater degree the individual

⁴ In many cases, no film was found to be present.



particles so that a more detailed study could be made, various dispersing agents were added to the dilute pigment suspension from which electron micrographs were prepared. After many unsuccessful attempts, electron micrographs in which the individual particles could be accurately measured were obtained. An electron micrograph in which individual particles can be seen is displayed in Fig. 1b. The dimensions of a number of particles of No. 600 pigment manufactured by each company were determined from electron micrographs made at 4274 diameters.

Twenty-five particles of No. 600 pigment manufactured by Company A, which varied in length from 0.374 to 0.702 micron, had an average length of 0.481 micron and a like number manufactured by Company B, which varied in length from 0.351 to 0.655 micron, had an average length of 0.525 micron.

DISCUSSION

A careful study of electron micrographs, taken at approximately 5,000 diameters,⁵ of various samples of yellow iron oxide pigment No. 620 made by two different pigment manufacturers reveals no appreciable difference in individual particle shape. Also, no difference in gross structure was detected in particles of pigment No. 600, manufactured by Companies A and B. All particles observed were rod-like in shape and had a ratio of length to width of approximately five.

The average length of particles of pigment No. 600, manufactured by Company A, based on twenty-five individual particles taken at random, was 0.481 micron. The average particle length of various samples of pigment No. 600, manufactured by Company B, based on a similar number of particles was 0.525 micron. It is felt that the slight difference (0.044 micron) in particle size is not significant.

The most recent and conclusive study of pigments reported in the literature was made by Tilleard and Smith in 1946. Tilleard and Smith investigated several different paint pigments, including the type⁶ studied by the investigators. They reported all particles of yellow iron oxide pigment to be rod-like in structure, and further that the dimensions of the majority of the particles measured were 0.5 micron by 0.1 micron.

Although all electron micrographs of yellow iron oxide paint pigments made by the authors were taken at a magnification of slightly less than 5,000 diameters, the results obtained are quite similar to those obtained by Tilleard and Smith with a much more powerful electron microscope.

⁵ All electron micrographs made in this study were made at 4274 diameters. This value of magnification was determined by calibration of the electron microscope preceding the investigation.

⁶ Although Tilleard and Smith do not state the manufacturer of the yellow iron oxide pigment investigated, since the work was done jointly at the British National Physical Laboratory and the Paint Research Station, it is reasonable to assume that the pigment was made in England.

CONCLUSIONS

Based on electron microscopic studies of yellow iron oxide pigments manufactured by two different companies, the following conclusions are set forth.

1. Specimens of yellow iron oxide pigments suitable for electron microscopic examination can be made quite satisfactorily by employing a water-borne collodion film.
2. The structure and particle size of yellow iron oxide paint pigments made by two major pigment manufacturers are essentially identical.
3. Particles of yellow iron oxide paint pigment are rod-like in form and approximately 0.5 micron in length.

ACKNOWLEDGMENTS

The authors wish to express their appreciation to the following who aided in one way or another during the progress of the investigation: Professor W. A. Murray, Dr. F. L. Robeson, and Professor M. V. Nevitt, all of the Virginia Polytechnic Institute, and Mr. Roy M. Garrett and Mr. John O. Rider of the American Pigment Corporation.

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Additional Records of the Occurrence of the Freshwater Jellyfish, *Craspedacusta sowerbii*, in Virginia

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The most recent report of the occurrence of *Craspedacusta sowerbii* in Virginia was that of Tresselt (1950)¹ who recorded its presence in Matoka Lake at Williamsburg, James City County, Virginia. Previous reports include those of Schmitt (1939)² and Hamaker and Milne (1937)³.

Dr. W. E. Brown of Charlottesville kindly presented the senior author with three specimens of this jellyfish which he had collected in Paynes Pond on August 13, 1950. Payne's Pond, which was destroyed by high water during 1952, was formed by an impoundment of Little Mechunk Creek, a tributary of the Rivanna River, in the northwestern part of Fluvanna County. The pond was visited on August 15 to look for additional specimens. Between 10:00 and 12:00 A. M. the sky was overcast, and thousands of medusae were seen. While the medusae were more abundant some 50 feet off shore, a few individuals were observed in water less than one foot deep. At this time approximately 200 specimens, ranging from one to 12 mm. in diameter, were collected and preserved. Subsequent visits to the pond later in the Fall and during the following year, however, failed to disclose their presence.

The junior author observed medusae in two localities during 1950 but did not preserve specimens from either of them. It is assumed that they were the same species as the other freshwater medusae recorded from the State.

In Holladay Lake, an impounded tributary of the Appomattox River in the eastern part of Appomattox County, he found many individuals in the lower portion where the water was comparatively deep. On the other hand, in Bear Creek Lake, a lake formed by a dam built on Bear Creek, also a tributary of the Appomattox River in Cumberland County, he found the medusae in the upper, shallow reaches. They were seen during the first week-end in September in the former locality, while in Bear Creek Lake they were present from late July through September.

The three localities in the Piedmont Province represent the westernmost records for this species in Virginia. It is hoped that others who observe jellyfishes in fresh water in the State will kindly inform one of the authors, both of whom are interested in ascertaining the range of this animal.

¹ Ecology, 31 (3): 478.

² Amer. Nat., 73 (744) 83-89.

³ Science, 86 (2238): 494.



Justus Henry Cline (*right*) discussing deer food habits with Editor of Virginia Wildlife in Big Levels Refuge.

JUSTUS HENRY CLINE

The Conservationist-Geologist of Virginia

The next time you are in Stuarts Draft, Virginia, go to the local farmer's supply store and the chances are that you will find Virginia's most famous and beloved conservationist-geologist sitting in an old chair passing the time of day with someone — it may be a 'teen age fisherman or a United States Senator. Justus Henry Cline, "Judd" to his many friends, is one of the Commonwealth's most sincere and active conservationists and geologists. He was born on a farm near Timberville, Virginia, obtained a Bachelor's degree from Bridgewater College, a Master's degree in geology from Northwestern University, taught geology and did research at the University of Virginia under Thomas L. Watson, and participated in exploration for oil in vast areas of the far west as geologist for several of the major oil companies.

His thoughts and ideas have always been far ahead of those of most people. Through his interest in wildlife protection, the Big Levels Wildlife Refuge was established. At the entrance to Sherando Lake Park a bronze plaque mounted on a boulder commemorates "Judd's" work in establishing this area as a haven for wild animals and man. Within full view of his boyhood home at Stuarts Draft, to which he has returned, is the latest monument to his foresight and geological knowledge, a dam impounding a lake which supplies ample water for one of the few rural water supply systems of the United States.

In May 1950 a volume on *The James River Basin — Past, Present and Future*, published by the Virginia Academy of Science, was dedicated to him jointly with Wortley F. Rudd. In May 1953 the members of the Academy again honored him by election as an Honorary Life Member. On June 1, 1953 his Alma Mater, Bridgewater College, recognized its famous alumnus by awarding him the degree of Doctor of Science.

Now when we go to Stuarts Draft we will ask at the feed store, the post office or at his home for Doctor Cline, but he will still prefer "Judd."

MARCELLUS H. STOW
Lexington, Virginia

News and Notes

(EDITOR'S NOTE: *News contributions should be sent to the person whose name appears at the end of the appropriate section.*)

PRESIDENT'S MESSAGE

The Editor of the Virginia Journal of Science has offered me this opportunity to say a few words to the members of the Virginia Academy.

Since the Academy was founded thirty years ago, the role of science in world affairs and its influence on the individual have changed greatly. Because of the increasing importance of science to our military and economic security, it has become more centralized, more secretive, and more mercenary. Consequently science is having less and less intellectual and spiritual appeal to the individual.

It is in the relationship of science to the individual, I believe, that the Virginia Academy may be able to play its most important role in the future. Because it is concerned with a greater appreciation of science by the local communities, because it is interested in the development of the individual scientist, because it embraces all of the natural sciences, because its members will undertake a difficult job which no one else will do, just so long as it needs to be done, such as the monograph on the James River basin, and because of many other similar reasons, I believe that the Virginia Academy renders a unique service in making science an integral part of the life of the community. It does this as no other organization that I know can do. It has appeal to the individual in that it is uncentralized, unsecretive, and unmercenary. It is a labor of love, and that is one reason why it can give to science that intellectual and cultural appeal which only voluntary activities possess.

It may be that such modest local organizations as the Virginia Academy of Science, which brings science down to earth and which relates it to the individual and to the local community, will in time save the day for science and democracy. Let us hope that the Virginia Academy will take full advantage of its opportunities to serve the state and nation in these respects where many mighty organizations cannot prevail.

— ALLAN T. GWATHMEY

MINUTES OF THE COUNCIL MEETING OCTOBER 12, 1952, LEXINGTON, VIRGINIA

The meeting of the Council of the Virginia Academy of Science was held in the library of Mallory Hall, of the Virginia Military Institute, Lexington, Virginia, October 12, 1952. President Lloyd C. Bird presided.

Present were Council members: Walter S. Flory, Jr., Ladley Husted, I. G. Foster, Sidney S. Negus, Marcellus Stow, Paul M. Patterson, Guy S. Horsley, Boyd Harshbarger, President-Elect Allan T. Gwathmey, and Foley F. Smith. Colonel S. M. Heflin and Mr. Truitt, of the Staff of V. M. I. were also present.

President Bird called the meeting to order at 9:45 A.M. The first order of business concerned the Virginia Academy Conference. It was proposed that the reading of the Committee reports be eliminated in order to save time; and be limited to five hundred words for printing in the Proceedings.

Marcellus Stow suggested that the reports be mimeographed in advance and be made available for each member desiring it for information previous to printing in the Proceedings. The reports of the Finance Committee, the Research Committee, and that of the Secretary would be read before the Conference; and copies of the reports should be sent to the Council in advance so that any controversial matters which might arise could be discussed before the meeting. It was properly moved and seconded that the Secretary instruct each person authorized to make a report to submit such Committee report to the Secretary at least a week before the annual Conference Meeting, and that copies of such reports be mimeographed on letter size paper and made available for all members who registered at the meeting.

It was further moved, seconded and passed, that such reports, or summaries of four hundred words or less be sent to the Editor-in-chief of the Virginia Journal of Science for publication; unless a more complete report for publication is required by the Council.

A sum of \$2,500 of the general funds was authorized to be invested in recognized securities, the income of which is to be used for general expenses of the Academy.

Marcellus Stow reported on the status of the proposed Dismal Swamp Project for the Long Range Planning Committee. He stated that the lowering of the water table in the swamp and the program of reforestation by the Camp Manufacturing Company would gradually change the swamp from its present natural status, and consequently the proposed study would not have the interest that was contemplated. He suggested that a further study be made of the situation, and a further report made at the Annual Meeting.

President Bird read a letter from Henry Leidheiser of the Virginia Institute of Scientific Research in which he suggested a "New Activities Com-

mittee." It was suggested that the President answer Mr. Leidheiser's letter, and appoint him on the Long Range Planning Committee.

President Bird told the Council about the William Ralston Memorial Award that had been established to encourage good expression in scientific writing. It was suggested that, subject to the approval of the Executive Committee of the Virginia Section, the Award might be handled advantageously through the Academy. After considerable discussion, the suggestion was approved in principle.

It was moved, seconded and passed, that President-Elect Allan T. Gwathmey, be appointed as a delegate to the Academy Conference of the AAAS at the St. Louis meeting, in addition to the Secretary.

After considerable discussion it was moved and passed that the customary Academy dinner, both Junior and Senior, be eliminated.

The Council recommended that the President contact college and university authorities regarding the possibility of increasing the value of scholarships offered to State Science Talent Search winners; and also the possibility of continuing such scholarships for four years.

It was moved, seconded and passed, that the fiscal year of the Academy be changed to correspond with the calendar year. This action is subject to the approval of the Academy at the Annual Meeting. It was suggested that the Secretary and Editor-in-chief work out details and conflicts which might arise due to such change.

Since such action would require change in the Constitution Article II, Section 2, which now reads: "The fiscal year of this organization shall be from April 1 to March 31." This to be changed to read: "The fiscal year of this organization shall be from January 1 to December 31." Publication of this notice in the Journal shall constitute the proper notice.

It was moved, seconded and passed, that the present fee of \$10.00 for the Collegiate Chapter be changed to \$3.00 per year, for which such Chapters will receive one subscription to the Virginia Journal of Science instead of two.

Dr. Boyd Harshbarger discussed bids offered for publication of the Journal for the coming year, and on his recommendation it was moved, seconded and passed, that the bids of the Pearisburg Virginian, by Malcolm Donald Coe, be accepted for two years. There being no further business the Council adjourned at 12:20 P.M.

Following lunch the President's Advisory Committee convened in the library at 2 P.M. Most of the members of the Local Committee on Arrangements were present and problems relative to the Annual Meeting at V. M. I. were discussed for the benefit of the committee.

Present were: Major Nichols, Colonel Anderson, Messrs. Dobson, Jarman, and Webb, of V. M. I.; Mrs. Zoe Black, Mrs. Vera Remsberg, Messrs. Stow, Brumfield, Jopson, Myster, Flory, Harshbarger, Obenshain, Patterson, Horsley, Weaver, Truitt, Gwathmey, Negus, Carroll, Foster, Smith, and Bird. Also Colonel Hefflin, Robert Jeffrey, and Mrs. B. G. Heatwole were present. Mr. Obenshain made a report to the group on the new

set-up of the Speakers and Councilors Bureau. Colonel Carroll, of V. M. I., reported on the activities of Collegiate members.

Mrs. Heatwole made a report on the plans for the program of the Junior Academy meeting and publicity that was being planned.

Colonel Anderson expressed the pleasure of V. M. I. in entertaining the Academy at its Annual Meeting.

The meeting adjourned at 5 P.M. — FOLEY F. SMITH, *Secretary*.

MINUTES OF THE COUNCIL MEETING RICHMOND, APRIL 18, 1953

A meeting of the Council of the Virginia Academy of Science was held at the Commonwealth Club, Richmond, April 18, 1953, at 12 o'clock noon. Present were: President Lloyd C. Bird, who presided; I. G. Foster; Walter Flory; President-Elect Allan Gwathmey; Edward Harlow, Boyd Harshbarger; Guy W. Horsley, Ladley Husted; Sidney Negus, Marcellus Stow, and Foley F. Smith. Mrs. B. G. Heatwole, Chairman of the Junior Academy of Science Committee, was present as a guest.

It was decided to hold the Annual Academy Conference on Thursday afternoon, May 7, at 5 P.M. in Mallory Hall, at the Virginia Military Institute. It was felt that since these conferences would be shorter, due to condensed reports, the meeting could be concluded within an hour.

President Bird asked for some committee reports, and comments were made by Marcellus Stow, for the Long Range Planning Committee, and for the Committee on Secondary Education. Mimeographed reports concerning these committees were distributed among those present.

Walter Flory, Chairman of the Research Committee, requested a statement of policy from the Council concerning various items of equipment which might be purchased through a grant-in-aid made to an individual by his committee. After much discussion it was moved, seconded, and passed, that each case be considered on its merits, and disposition of such equipment be left to the discretion of the committee.

Mrs. Heatwole was congratulated on having been awarded a Ford Travelling Scholarship in the amount of \$4,300 which would allow her to take a year's leave of absence to do some creative writing and visit various high schools throughout the country and observe their secondary science teaching program.

Recognition was made of the fact that two scholarships available to teacher sponsors; one each offered by the College of William and Mary and the University of Virginia, to the Biological Station at Mountain Lake, had been increased to \$200.00 each, by these institutions.

Dr. Guy Horsley commented on the encouragement received so far in planning to establish an endowment fund, the interest of which would be utilized in carrying on the Junior Academy and Science Talent Search program.

The matter of establishing a scholarship to be awarded by the Academy was referred to the Finance Committee.

President Bird stated that the University of Virginia, Department of Education, was making some plans to study the careers and accomplishments of former State Science Talent Search winners, and to make such a study continuous from year to year.

It was suggested that the incoming administration further consider the problem of Collegiate Chapters of the Academy and suggest that the present committee be discharged at this time.

It was noted that the Committee on Resource-Use Education had arranged a program for one of the first symposia that has ever been held by the Academy including more than one section.

President Bird read a letter from Dr. Baldwin, of William and Mary, proposing the establishment of a chair of Botany. It was moved, seconded and passed, that such a proposal was not feasible at this time and that President Bird write Mr. Baldwin to this effect.

The problem of the State Science Museum was discussed and it was suggested that the Academy study a new approach to secure an adequate building; as it was felt that the State Finance Building would not be available at any time in the near future.

I. G. Foster reported for the Local Committee on Arrangements for the annual May meeting at the Virginia Military Institute, and stated that everything possible had been done to insure a successful meeting.

In order to be able to furnish better service to the individual sections of the Academy, it was suggested that the addressograph plates now used by the Virginia Journal of Science, and located in Blacksburg be brought to Richmond and turned over to a mail service company which could better maintain an up-to-date correct list of members; and could more readily and promptly make requested changes in the file than could be done at present. A bid for this contract from the Expert Letter Writing Company of Richmond, advised that such service of tabbing the plates for automatically addressing envelopes and bill heads, etc., for the various sections, and the Academy as a whole; and proper maintenance of addressograph plates including changes and addressing envelopes for mailing the Journal could be done for forty-five to fifty dollars per year.

The suggestion was favorably received by all present and it was suggested that official action be taken at the May meeting, after further study by the Editor-in-chief of the Journal.

At the suggestion of Boyd Harshbarger it was moved, seconded and passed that Malcolm D. Coe of the Giles County Virginian, publishers of the Virginia Journal of Science, be commended for his personal interest in supervising the publication of the Journal.

The William Ralston Award was established in 1949 to encourage clarity of expression and accuracy in the preparation of scientific papers. Under a plan that has evolved this year, undergraduate students in Chemistry, Physics, Biology, Engineering, Astronomy, Mathematics, Geology, and Agricultural Science, as well as medical students, are eligible. Sections of

the Virginia Academy of Science, embracing these fields, have been asked to cooperate in securing suitable papers. Under this plan, the Awards Committee of the Virginia Section, ACS will continue the administration of the Award. The Chairman of the Virginia Section ACS will make the Award at the annual meeting of the Academy.

It was also moved, seconded, and passed that Edward Dyer, Chairman, of the Science Talent Search Committee and Mrs. B. G. Heatwole be commended for their excellent work in preparing and conducting the program instituted by these committees during the past year.

It was moved, seconded, and passed that Justus H. Cline of Stuarts Draft, be elected an Honorary member of the Academy. A properly embossed certificate will be presented to him at the annual meeting.

It was moved, seconded, and passed that the President appoint a standing committee to study and to select those members of the Academy to be elected to Honorary membership.

President-Elect Gwathmey suggested the possibility of securing grants from the Research Corporation, over and above those made available by the Virginia Academy of Science. He was requested to study this possibility further.

There being no further business the Council adjourned at 3:30 P.M.

— FOLEY F. SMITH, *Secretary*

SECTION NEWS

CHEMISTRY SECTION

Lloyd Campbell Bird, President of Phipps and Bird, Inc., of Richmond, Virginia and a member of the Virginia State Senate has been selected by the Awards Committee of the Virginia Section, American Chemical Society, to receive its annual Distinguished Service Award given for outstanding contributions to the professional standing of chemists.

Miss Susie V. Floyd, Science Instructor at Newport News High School, Newport News, Virginia, was also selected by the Virginia Section to receive a Distinguished Service Award for 1953 in recognition of her outstanding contributions to the stimulation of interest in high school science.

Mrs. Thelma Crowley Heatwole, Chemistry and Science Instructor at Wilson Memorial High School, Fishersville, has been awarded a \$4,300 fellowship for a year's special study by the National Committee on High School Teacher Fellowships, set up by the Ford Foundation. Of the hundreds of high school teachers over the country who were nominated for this honor, about twenty-five science teachers were selected. Mrs. Heatwole is the first teacher of secondary school science in Virginia to receive this Ford Fellowship. The grant covers travel, study and research in Mrs. Heatwole's special fields, and will also allow her to devote some of her time to writing projects in which she is interested.

Mrs. Heatwole has been honored in many ways as an inspiring teacher of high school chemistry. In 1949 the Virginia Section of the American Chemical Society presented her with its Distinguished Service Award for

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outstanding contributions to high school teaching. For a number of years, her students have been winners in the National and State Science Talent Searches and Virginia Junior Academy of Science contests. At the present time she is chairman of the Virginia Academy of Science committee for the encouragement of "junior scientists" in the State. Mrs. Heatwole will begin her special work next fall.

Dr. James K. Shillington, who received his doctorate at Cornell University and who is now teaching at Amherst College, has been appointed to the chemistry staff at Washington and Lee University as an assistant professor.

Bentz B. Howard of Danville, Virginia, who receives his degree in chemistry this year from W. and L., has been awarded a National Research Council Fellowship and will study at Princeton University.

Mr. D. K. Marchand has resigned his position on the chemistry staff at the Virginia Military Institute to accept a position at Washington and Jefferson College, Washington, Pennsylvania.

Dr. Gene Wise and Dr. B. W. Mundy, both of the V. M. I. staff, have accepted summer positions. Dr. Wise will serve as a research assistant in the chemistry department of Northwestern University, and Dr. Mundy has been appointed to the summer school staff at the University of Virginia.

Mr. Charles W. Bondurant has resigned his position on the chemistry staff at Hampden-Sydney College to resume graduate work at the Virginia Polytechnic Institute next fall. Mr. James B. Worsham, Jr., who receives his doctorate from Duke University this June, will replace Mr. Bondurant on the Hampden-Sydney staff.

Recent additions to the staff of the Virginia Institute For Scientific Research include Felix von Gemmingen and Donald Koenig, both of whom hold master's degrees. Mr. Gemmingen is a graduate of V. M. I. and Rensselaer Polytechnic Institute and will be in charge of X-ray work and the electron microscopy section. Mr. Koenig comes from the University of Pittsburgh and will assist in ultracentrifugal studies on protein materials.

Dr. Robert C. Krug, Associate Professor of Chemistry at V. P. I., will join the summer staff of the Virginia Institute For Scientific Research to study the properties of organic single crystals.

— CARL J. LIKES, *Virginia Institute For Scientific Research*

ENGINEERING SECTION

The Aeronautical Engineering Department of V. P. I. has announced the return of Assistant Professor James B. Eades, following two years on active duty with the Navy, and the appointment of Mr. Fred W. Martin as Instructor in Aeronautical Engineering.

A recent publication from the Aeronautical Engineering Department of V. P. I. is "A Method for Location of Detached Shock Waves Ahead of Plane Bodies", by R. W. Truitt, in the Journal of the Aeronautical Sciences, January, 1953.

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The Aeronautical Engineering Department of V. P. I. has secured a research contract with the U. S. Air Force, Air Research and Development Command, to undertake a theoretical investigation in the transonic range over simple wedges.

Mr. Kenneth C. Rathbun has joined the staff of Experiment Incorporated in Richmond as a Research Associate. Mr. Rathbun is a graduate of the University of Virginia, 1942, and recently attended M. I. T. obtaining his Master's degree.

Two recent publications in the Transactions of ASME announced by Experiment Incorporated are "Static Dynamic Load Machine for High Pressure" by E. G. Dorsey, Jr. and E. T. Fleischauer, and Seals to Minimize Leakage at Higher Pressures" by B. A. Niemeier.

Dr. Joshua S. Bowen, Jr., who obtained the Ph.D. degree in Chemical Engineering from Johns Hopkins University, and Mr. John Albert Rolston, who recently obtained the M.S. degree from North Carolina State have joined the staff of the Engineering Experiment Station of the University of Virginia.

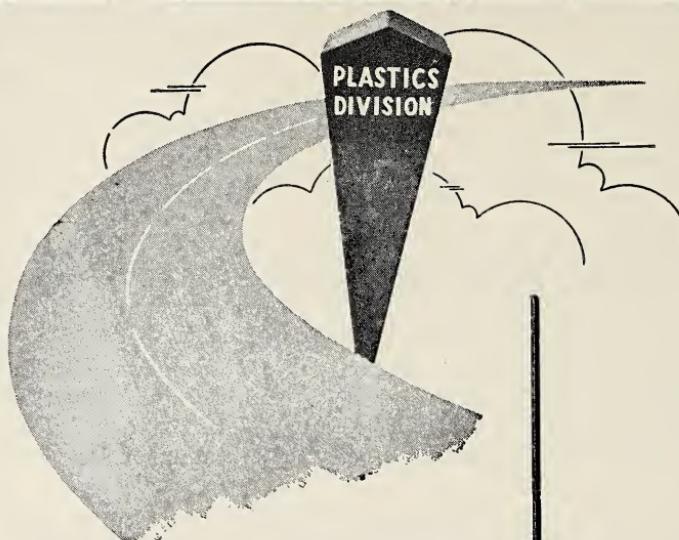
Dr. James Hubert Gary joined the staff of the Department of Chemical Engineering of the University of Virginia in September 1952. He obtained the B.S. degree in Chemical Engineering in June 1942 and the M.S. degree in September 1946 from V. P. I., and the Ph.D. in Chemical Engineering from the University of Florida in June 1951. He was most recently employed as an engineer in charge of a pilot plant development group by the Standard Oil Company of Ohio. He holds the rank of Assistant Professor of Chemical Engineering and is in charge of a research project in the Engineering Experiment Station sponsored by the Engineer Research and Development Laboratories at Fort Belvoir.

Assistant Professor J. W. Eldridge of the University of Virginia Department of Chemical Engineering and Mr. M. G. Selden have published an article entitled "Coating Ingredients from Tall Oil" in the monthly journal of the Technical Association of the Pulp and Paper Industry.

The Second Annual Highway Materials Conference was held March 31 and April 1 and 2 at the Virginia Council of Highway Investigation and Research located at the University of Virginia in Charlottesville. More than twenty members of the Highway Department Testing Division, District Materials Engineers and members of the Research Council Staff met in informal sessions to discuss materials problems and to exchange information.

Mr. Tilton E. Shelburne, Director of Research of the Virginia Council of Highway Investigation and Research was elected First Vice-President of the Virginia Section of the A.S.C.E. on December 5 when the Society met at Richmond's Hotel Jefferson.

Research publications of the Virginia Council of Highway Investigation and Research from the Proceedings of Highway Research Board include "Curing of Soil-Cement Bases", by A. W. Maner, and "Temperature Variation and Moisture Retention of Concrete Curing Methods" by Phillip L.



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Melville and R. W. Czaban. Bulletin No. 57 of the Highway Research Board includes a paper entitled "Field Studies of Traffic Paints" by Til-ton E. Shelburne, A. L. Straub, and R. L. Sheppe. — N. F. MURPHY

PSYCHOLOGY SECTION

The Virginia Examining Board for Clinical Psychologists met in Richmond on May 23. Mr. Ralph W. Colvin and Mr. Edward V. Malcom were recommended for certification on the basis of examination. Mr. William Morgan was also interviewed and will be recommended for certification by reciprocity, since he already holds the certificate of the American Board of Psychological Examiners.

The College of William and Mary is inaugurating a program of graduate instruction in Psychology, featured by a work-study plan sponsored jointly by the College and the Eastern State Hospital. Two students per year will be accepted for this program calling for half-time work as an intern in abnormal psychology at the Hospital, combined with graduate study in general and experimental psychology at the College. This program will lead to the M.A. degree at the end of two years.

The Washington and Lee chapter of Psi Chi initiated Mr. Frank A. Geldard as a member on May 1. Mr. Geldard addressed the chapter on the topic, "Psychological Problems in the Defense Situation."

Three Virginia psychologists participated in the 45th annual meeting of the Southern Society for Philosophy and Psychology, held at the University of Texas on May 2-4. Mr. Frank A. Geldard gave an address, "Scientific Psychology in a Troubled World" at the dedication of Mezes Hall, new psychology laboratory at the University of Texas. Mr. Henneman of the University of Virginia and Mr. Hinton of Washington and Lee presented papers in two of the sessions. Mr. Hinton also serves as the treasurer of the Society.

At the National Conference on Airborne Electronics held in Dayton, Ohio, on May 11-13, Mr. Henneman read a paper, "Communication During Complex Task Performance", reporting investigations which had been directed by Mr. L. S. Reid and himself at the University of Virginia under a research contract with the U. S. Air Force. — RICHARD H. HENNEMAN

STATISTICS SECTION

Dr. David B. Duncan of Virginia Polytechnic Institute, has been invited to address the American Chemical Society, Division of Industrial and Engineering Chemistry, on September 6-11, 1953, at their Symposium on "Statistics in the Design of Experiments". The title of his talk will be, "Multiple Range Tests and the Multiple Comparisons Test".

For a detailed paper, based on part of the research reported here, presented at the Annual Meeting of the Academy, May 1953, Messrs. Berko and Hereford received the *J. Shelton Horsley Award*. This award is made annually in recognition of the "most highly meritorious paper" presented at the Annual Meeting.



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The Division of Statistics and the Division of Markets of the Department of Agriculture, completed a survey of apple and peach trees in commercial orchards. A preliminary report by Henry M. Taylor and Glenn W. Suter was published in March.

Clifford Sims, a former member of the Academy, was transferred to New Jersey in September 1952 and placed in charge of the New Jersey Crop and Livestock Reporting Service of B. A. E. of U. S. D. A.

Thomas L. Stuart, Agricultural Statistician, a native of North Carolina, was transferred from the Alabama office of B. A. E. to Virginia as replacement for Clifford Sims in Crop and Livestock Reporting Service of B. A. E.

Dr. Paul N. Sommerville has been appointed Associate Professor of Statistics at The Virginia Polytechnic Institute. His chief interest will be in Theory Sampling and directing sampling surveys. Dr. Sommerville received his B.Sc. Degree, Magna Cum Laude, in 1945 at the University of Alberta in the honors curriculum in Mathematics. He received his Ph.D. at the University of North Carolina in Statistics in 1953. He has been Principal of a High School in Canada and has had previous research experience with the Defense Research Board in Canada. Dr. Sommerville has published numerous papers including the following:

1. Methods of Estimating the Required Sample Size.
2. A Statistical Study of Flying Accidents in the Royal Canadian Air Force.
3. Optimum Sample Sizes for Choosing the Largest of $(k + 1)$ Means Using Minimax Methods.
4. Optimum Sample Size for Choosing the Largest of $(k + 1)$ Parameters from $(k + 1)$ Otherwise Identically Distributed Populations.

The Department of Statistics has just been awarded a three-year contract with the Army Quartermaster Corps. On this contract there will be three appointments. Two of the appointees are Hale Sweeny and Thomas S. Russell. Mr. Sweeny received his Bachelor's Degree in Mechanical Engineering and his Master's Degree in Industrial Engineering and has completed further work in Statistics. For the past year he has been an Instructor in Industrial Engineering. Mr. Russell received his B.A. Degree from Wake Forest University and his Master's Degree in Chemistry at the Virginia Polytechnic Institute and has completed two years of graduate work in Statistics. He was formerly an Instructor of Mathematics at the Virginia Polytechnic Institute and held a teaching fellowship in the Department of Statistics. — WALTER HENDRICKS

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NOTICE TO CONTRIBUTORS

Contributions to the Journal should be addressed to Horton H. Hobbs, Jr., Miller School of Biology, University of Virginia, Charlottesville, Virginia. If any preliminary notes have been published on the subject which is submitted to the editors, a statement to that effect must accompany the manuscript.

Manuscripts must be submitted in triplicate, typewritten in double spacing on standard $8\frac{1}{2}'' \times 11''$ paper, with at least a one inch margin on all sides. Manuscripts are limited to seven pages, with the proviso that if additional pages are desired, the author may obtain them at cost.

Division of the manuscript into subheadings must follow a consistent plan, and be held to a minimum. It is desirable that a brief summary be included in all manuscripts.

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Explanations of figures, Graphs, etc., should be typed on separate pages. All figures should be numbered consecutively beginning with the first text figure and continuing through the plates. If figures are to be inserted in the text this should be clearly indicated by writing "Figure —" at the appropriate place in the margin.

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PROCEEDINGS FOR THE YEAR

1952-1953



VOL. 4, NEW SERIES

SEPTEMBER, 1953

No. 4

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Pages

Proceedings for the Year 1952-1953

Minutes of the Thirty-First Annual Meeting, May 6, 7, 8, 9, 1953

Detailed Table of Contents 162

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Proceedings for the Year
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MAY 6, 7, 8, 9, 1953

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T. V. Downing	Harry S. Jopson	Charles F. Lane
Henry S. Mósby	E. W. Mundie	Elizabeth Perry
Paul Sanders	Ross H. Walker	D. S. Wallace
Percy H. Warren	I. D. Wilson	A. L. Wingo

VIRGINIA FLORA

A. B. Massey, *Chairman*

Virginia Polytechnic Institute

Lena Artz	R. P. Carroll	Walter S. Flory
George C. Mason	Paul M. Patterson	

VIRGINIA FAUNA

Horton H. Hobbs, Jr., *Chairman*

Department of Biology, University of Virginia

SPEAKERS

Percy H. Warren, *Chairman*

Madison College, Harrisonburg

RESOLUTIONS

William E. Trout, *Chairman*

Department of Chemistry, University of Richmond

James W. Cole

PLACE OF MEETING

Ladley Husted, *Chairman*

Department of Biology, University of Virginia

Carl J. Likes

A. M. Showalter

STATE SCIENCE MUSEUM

George W. Jeffers, *Chairman*

Longwood College, Farmville

LOCAL ARRANGEMENTS

Frederick W. Young, *Chairman*

Cobb Chemical Laboratory, University of Virginia

Frederick L. Brown	Edwin E. Floyd	Paul M. Gross
Richard H. Henneman	B. F. D. Runk	Otis L. Updike

SCIENCE TEACHING IN SECONDARY SCHOOLS

Francis G. Lankford, *Chairman*

Peabody Hall, University of Virginia

Paul H. Cale	John B. Chase	James W. Cole
Byron N. Cooper	William M. Hinton	George W. Jeffers
F. D. Kizer	Robert O. Nelson	Percy H. Warren

VIRGINIA JOURNAL OF SCIENCE

(Elected by Council)

Boyd Harshbarger, Editor-in-Chief

Virginia Polytechnic Institute, Blacksburg

Horton H. Hobbs, Jr., Technical Editor

Mary E. Humphreys, Assistant Technical Editor

SECTION EDITORS

(Elected by Sections)

Wesley P. Judkins	Agricultural Sciences
I. G. Foster	Astronomy, Mathematics and Physics
J. Douglas Reid	Bacteriology
Robert T. Brumfield	Biology
Carl J. Likes	Chemistry
Francis G. Lankford, Jr.	Education
Robert Hubbard	Engineering
W. D. Lowry	Geology
Ebbe C. Hoff	Medical Sciences
Richard H. Henneman	Psychology
L. W. Jarman	Science Teachers
Walter Hendricks	Statistics

Contents

LIST OF PRESIDENTS	156
OFFICERS AND COMMITTEES FOR 1952-53	157
JEFFERSON MEDAL WINNERS	164
HORSLEY AWARD	164
GENERAL PROGRAM — THIRTY-FIRST ANNUAL MEETING	166
MINUTES OF MEETING OF COUNCIL	168
MINUTES OF ACADEMY CONFERENCE	169
 Reports of	
Secretary-Treasurer	171
 Committees:	
Long Range Planning	181
Research	182
Finance and Endowment	183
Junior Academy of Science	184
Science Talent Search	187
Activities for Collegiate Members	189
Membership	190
James River Project	190
Resource-Use Education	191
Virginia Flora	192
Speakers and Counsellors	193
Resolutions	193
Place of Meeting	194
Local Arrangements	194
Science Teaching in Virginia Schools	195
Virginia Institute for Scientific Research	198
Virginia Journal of Science	199
MINUTES OF THE ACADEMY MEETING	202

MINUTES OF THE COUNCIL MEETING, OCTOBER 12, 1952	204
MINUTES OF THE JUNIOR ACADEMY OF SCIENCE	207
SECTIONS:	
Agricultural Sciences	209
Astronomy, Mathematics, and Physics	215
Bacteriology	225
Biology	228
Chemistry	233
Education	244
Engineering	250
Geology	258
Medical Sciences	269
Psychology	276
Science Teachers	283
Statistics	286
LIST OF MEMBERS	294
LIST OF STUDENT MEMBERS	322
MEMBERSHIP APPLICATION	325
FORM OF BEQUEST	325

JEFFERSON MEDAL WINNERS

RECIPIENTS OF THE JEFFERSON GOLD MEDAL.¹

Alfred Chanutin	1936
William B. Porter	1937
H. M. Phillips	1938
G. M. Shear and H. D. Ussery	1939

RECIPIENTS OF THE JEFFERSON PRIZE²

L. G. Overholzer and John H. Yoe	1940
Allan T. Gwathmey	1941
R. N. Jefferson	1942
W. H. Hough	1943
Clinton B. Cosby	1944

RECIPIENTS OF J. SHELTON HORSLEY

RESEARCH AWARDS

CARL C. SPEIDEL	1927
JOHN H. YOE	1928
J. C. STREET	1929
H. E. JORDAN	
CARL C. SPEIDEL	1930
E. C. STEVENSON	1931
JAMES H. SMITH	1932
S. A. WINGARD	1933
E. P. JOHNSON	1934
MARGARET HESS	1935
ALFRED CHANUTIN	1936
R. G. HENDERSON	1937
S. G. BEDELL	1938
M. J. MURRAY	
F. F. CLEVELAND	1939
WALTON C. GREGORY	1940
CHARLES RAY	1941
No AWARD	1942
J. B. MEYER	1943
J. H. TAYLOR	1944
No AWARD	1945

¹ The winning papers in this competition were entered against those of the North Carolina, South Carolina, Georgia and Florida Academies of Science. It was discontinued in 1940.

² The winning authors had the choice of the Jefferson Prize or the Academy Prize during this period. The name of the Academy Prize was changed to the J. Shelton Horsley Award; and the Jefferson Prize discontinued in 1944.

BOYD HARSHBARGER

D. B. DeLURY (separate papers)	1946
No AWARD	1947
HENRY LEIDHEISER, JR.	1948
WALTER S. FLORY, JR.	1949
ERLING S. HEGRE	1950
DAVID B. DUNCAN	1951
D. R. H. GOURLEY	1952
STEPHEN BERKO	
FRANK L. HEREFORD	1953

General Program of the Thirty-First Annual Meeting **1 9 5 3**

VIRGINIA MILITARY INSTITUTE

LEXINGTON, VIRGINIA

WEDNESDAY, MAY 6

- 3:00 P.M. to 8:00 P.M. — Registration for Junior Academy members, participants in the Science Talent Search, Academy members, and guests, Room 354, Mallory Hall.
- 3:00 P.M. to 8:00 P.M. — Setting up Exhibits: Commercial, Rooms 335, 341, Mallory Hall; Free, Room 359, Mallory Hall; Junior Academy, Rooms 435, 441, 459, Mallory Hall.

THURSDAY, MAY 7

- 8:00 A.M. to 8:00 P.M. — Registration for Junior and Senior Academy members and guests, Room 354, Mallory Hall.
- 9:00 A.M. — Meeting of Science Exhibit Judges; Room 434, Mallory Hall.
- 9:30 A.M. — Meeting of chairman and exhibitors; Room 434, Mallory Hall.
- 10:00 A.M. to 12:30 P.M. and 1:30 P.M. to 4:00 P.M. — Meeting of Finalists of Talent Search with Chairman and interviewers; Rooms 434, 442, 454, 242, 249, 252, Mallory Hall.
- 10:00 A.M. to 12:30 P.M., 1:30 P.M. to 4:00 P.M. — Judging of Science Exhibit Contests; Rooms 45, 441, 459, Mallory Hall.
- 3:00 P.M. — Meeting of the Talent Search Committee; Room 434, Mallory Hall.
- 3:30 P.M. — Meeting of all Senior Academy Section Officers; Room 257, Mallory Hall.
- 4:00 P.M. — Meeting of the Section Editors, Room 237, Mallory Hall.
- 4:30 P.M. — Regimental Parade, Parade Ground.
- 5:00 P.M. — Senior Academy Conference and General Meeting; Room 111, Mallory Hall.
- 7:30 P.M. to 8:30 P.M. — Business meeting, Junior Academy of Science; Auditorium, Preston Library.
- 8:30 P.M. — General Electric "House of Magic" for Junior Academy members and guests; Jackson Memorial Hall.

FRIDAY, MAY 8

- 8:00 A.M. to 6:00 P.M. — Registration; Room 354, Mallory Hall.
- 9:00 A.M. — Section Meetings: Agricultural Sciences, Room 234, Mallory Hall; Astronomy, Mathematics, Physics, Room 111, Mallory Hall; Bacteriology, Room 44, Mallory Hall; Biology, Room 147, Mallory Hall; Chemistry, Room 102, Maury-Brooke Hall; Education, Room 454, Mallory Hall; Engineering, Room 105, Nichols Engineering Hall, Geology, Room 249, Mallory Hall; Medical Science, Room 442, Mallory Hall; Psychology, Room 18, Scott-Shipp Hall; Science Teachers, Room 252, Mallory Hall; Statistics, Room 237, Mallory Hall.
- 10:30 A.M. — Presentation of awards, Junior Academy; student presentation of exhibits. Address by John C. Fisher, Metallurgy Research Department, General Electric Company, Auditorium, Preston Library.
- 12:30 P.M. — Group Luncheons.
- 2:00 P.M. — Section Meetings.
- 3:30 P.M. to 4:45 P.M. — Symposium "Resource Use Education", sponsored by Virginia Resources Use Education Council, Lecture, Old Science Hall.
- 4:30 P.M. to 6:00 P.M. — Superintendent's Reception for members and guests of the Academy; Alumni Hall.
- 7:30 P.M. — Business Meeting, Senior Academy, Room 147, Mallory Hall.
- 8:30 P.M. Address by Professor Hubert N. Alyea, Frick Chemistry Laboratory, Princeton University, "ATOMIC ENERGY: WEAPON FOR PEACE."

SATURDAY, MAY 9

- 9:00 A.M. — Section Meetings.
- 10:00 A.M. — Academy Council Meetings; Room 631, Preston Library.
- 2:00 P.M. — Field trips.

MINUTES OF THE COUNCIL MEETING MAY 9, 1953

A meeting of the Council of the Virginia Academy of Science was held in Room 631, Preston Library, Virginia Military Institute, 10:00 A.M., May 9, 1953. Presented were Lloyd C. Bird; I. G. Foster; Boyd Harshbarger; Horton H. Hobbs; Ladley Husted; Sidney S. Negus; Paul M. Patterson, and Foley F. Smith. President Allan T. Gwathmey presided.

Minutes of the last meeting were read and approved. Boyd Harshbarger suggested that a biographical sketch with picture of the Honorary members be carried in the Virginia Journal of Science upon their election as such. This was made as a motion and properly seconded and passed. Ladley Husted suggested that a plaque be placed at the Botanical Garden at the University of Virginia, honoring Ivey F. Lewis, a Past President of the Academy, and Honorary member. A committee was appointed by the President consisting of Messers. Husted, Strickland, and Carroll to investigate the cost of such a memorial.

President Gwathmey discussed standardizing procedure concerning the operation of the Junior Academy of Science for the next meeting; meaning that operational rules and procedures be stabilized as a guide for future members and chairmen of this committee. The President appointed the following Committee to study this problem and make a formal report to Council at the next meeting: Edward Harlow, Edward Dyer, Mrs. Thelma Heatwole, and I. G. Foster, Chairman.

It was suggested that the Section Chairman be asked to work up their respective programs for the next meeting with a view of receiving some papers in that section which might have science news value. Mr. Robert Jeffreys, Public Relations Officer for the Virginia Military Institute, offered suggestions for securing newsworthy papers previous to the meeting in order that newspapers would be advised of their content in time to get some publicity before and during the meeting rather than following it.

The President said he would appoint a Committee on Public Information, which would contact the Section Editors and suggest getting the program together far enough in advance for the screening of papers. This committee was to report at the next meeting of the Council.

President Gwathmey announced that Fred Young had been appointed Chairman of the Committee for Local Arrangements for the Charlottesville meeting for 1954.

It was moved, seconded, and passed that the Committee on Collegiate Activities be abolished.

The meeting adjourned at 12 P.M.

FOLEY F. SMITH, *Secretary.*

MINUTES OF THE ACADEMY CONFERENCE MAY 7, 1953

The Annual Meeting of the Academy Conference was held in Room 111, Mallory Hall, Virginia Military Institute, Thursday, May 7, 1953, at 5:00 P.M. A quorum of more than forty members being present, President Lloyd C. Bird called the meeting to order and introduced Colonel Anderson, who welcomed the Virginia Academy of Science on behalf of the Virginia Military Institute.

Colonel Heflin, Chairman of the Local Committee on Arrangements, made several announcements pertaining to changes in the program and meeting room arrangements.

President Bird then introduced Dr. James W. Cole, who brought greetings from the National Science Foundation to the Virginia Academy of Science, on the occasion of its Thirty-First Annual Meeting.

It was moved, seconded, and passed, that the change in the Constitution, notice of which was previously published in the Virginia Journal of Science, effecting Section II, Article 11 of the Constitution be changed to read: "that the fiscal year of this organization shall be from January 1 to December 31"; this change making the fiscal year of the Academy coincide with the calendar year.

President Bird discussed the necessity for having facilities for mailing notices, etc., to the various sections. In order to do this it would be necessary to bring the present addressograph plates used by the Virginia Journal of Science up to date, so that they could be tabbed for selective use by sections of the Academy, thus enabling the Academy to render better service to the various sections when they should require it.

Bringing the addressograph plates to Richmond and placing them in the hands of direct mailing service would require a change in the By-Laws, notice of which has already been made by publication in the Virginia Journal of Science. The change is to be made by the elimination of the phrase "shall make all new address plates"; from sub-section 5 of Section 5, of the By-laws. Editor-in-Cheif Boyd Harshbarger requested the following expression from him be inserted in the Minutes:

"I would be in favor of it provided that:

(1) The Editor-in-Chief of the Journal send all changes of address directly to the firm with the addressograph contract and that a duplicate copy of such changes be sent at the same time to the secretary of the Academy.

(2) That the secretary in adding names to the existing list send copies to both the addressograph firm and the Editor-in-Chief and that no names be added except when accompanied by two dollars (\$2.00) to the Editor-in-Chief for the Journal."

President Bird discussed the origin and background of the Academy Conference and how it afforded an opportunity for all members of the Academy to discuss various problems concerning the various sections and

allowed the officers to make their annual reports. As the Academy grew, however, the Conference became unwieldy, and in order to cut down the time-consuming reading of reports the Council recommended that the committee reports be mimeographed and made available for those members registering at the Annual Meeting.

The reports of the Secretary-Treasurer and those of various committees follow:

President Bird introduced President-Elect Allan T. Gwathmey, after which the meeting adjourned at 6:05 P.M.

FOLEY F. SMITH, *Secretary.*

REPORT OF THE SECRETARY-TREASURER

The report of the auditor reviewing the accounts and finances of the Academy for the past fiscal year is included in the Committee reports. The Finance Committee has studied this report and their comments will be made in their report and in the presentation of the budget.

This year, the Junior Academy of Science Committee, under the able direction of Mrs. Thelma G. Heatwole, and the Science Talent Search Committee, under the direction of Mr. Edward Dyer, of the University of Virginia, combined their committees to effect more efficient operation for these very important Academy functions. The two Chairmen of this committee are to be congratulated for their energetic work, both in raising funds to help defray expenses of the winners of the Talent Search to the annual meeting and for their work in the Science Open House meetings held at various institutions throughout the State. Detailed reports of these and other committees are available in mimeographed form at the Registration desk, and will be published in the Proceedings.

On recommendation of Council, an effort has been made to streamline the Academy Conference by eliminating the reading of all the committee reports, other than those of the Secretary, Finance, and Research Committee. It is believed that this will shorten the Conference without affecting the operation of the Academy as a whole.

The Academy was represented at two AAAS Council meetings at St. Louis, Missouri, December 26-31, 1952 by your Secretary; and represented at the AAAS Academy Conference by the Secretary and Mrs. Thelma G. Heatwole. Also present at this meeting was Dr. Arthur Bevan, Past-President of the Virginia Academy, and now of the Staff of State Geologist of Illinois. Elected as President for the Academy Conference for 1953 was Wayne Taylor, of Denton, Texas, Chairman of the Texas Science Talent Search, and Secretary of their Junior Academy. Other members of the Virginia Academy present at St. Louis were James W. Cole, of the National Science Foundation, Felix Saunders, Martinsville, Miss Samuella Crim, of New Market, Sidney S. Negus, Richmond, Professor Harry E. Alden, University of Virginia, and others.

The new Chairman of the Membership Committee, Dr. Henry Leidheiser, of the Virginia Institute of Scientific Research, has done an outstanding job as will be noted in his report. Each member of the Academy should be an active member of this committee, and we hope to attain at least twelve hundred members for 1953. Our present active membership is all the more reason that we should have a steady growth each year.

It was recommended by Council that the fiscal year be changed to the calendar year, which will require revision of the Constitution.

It is believed that greater service can be rendered the individual sections of the Academy and to the Virginia Journal of Science by transferring the Academy addressograph plates to a commercial mailing service company. This will make the addressograph files of the Academy more

flexible; more readily available for use by the various sections, and will greatly decrease the work of the Editor-in-Chief and Secretary, in maintaining an up-to-the-minute file.

FOLEY F. SMITH, *Secretary-Treasurer.*

Richmond, Virginia

April 17, 1953

The Officers and Council Members

Virginia Academy of Science

Richmond, Virginia

Gentlemen:

I have made an examination of the Secretary-Treasurer's books of account and record of

VIRGINIA ACADEMY OF SCIENCE, RICHMOND, VIRGINIA

for the year ended March 31, 1953, and submit herewith my report thereon consisting of the statements listed in the foregoing index.

The Statements of Cash Receipts and Disbursements, Exhibits "B" and "C" reflect the General Fund and Research Fund cash transactions for the year ended March 31, respectively. The cash in bank was verified by direct correspondence with the depositary bank and the balances reported were reconciled with the amounts shown on the Consolidated Fund Balance Sheet, Exhibit "A". The cash receipts of record were traced in total to the record of their deposit in bank, and all recorded disbursements were evidenced by properly signed cancelled checks with the exception of those checks outstanding at the balance sheet date.

The amounts shown on the Consolidated Fund Balance Sheet, Exhibit "A", and Statements of Cash Receipts and Disbursements, Exhibits "D", "E" and "F", relating to Trust Fund Accounts were taken from the March 31, 1953, report of the Trust Agent, First and Merchants National Bank of Richmond and were not verified in any manner beyond the confirmation of cash balances.

Income remitted to your Treasurer by the Trust Agent was traced to record of deposit in the bank.

In my opinion, the accompanying statements present fairly the position of the Virginia Academy of Science at March 31, 1953, and the results of its financial operations for the fiscal year, in confirmation with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

Respectfully submitted,

J. WADDELL RISON,

Certified Public Accountant.

VIRGINIA ACADEMY OF SCIENCE

RICHMOND, VIRGINIA

MARCH 31, 1953

EXHIBIT "A"

ASSETS

GENERAL FUND:

Cash in Bank (Exhibit "B")	\$ 2,665.95
Investments (At Cost):	
Preferred Stocks (Market Value \$2,372.00)	2,445.95
Due from the Virginia Journal of Science	321.75

<i>Total General Fund</i>	\$ 5,433.65

RESEARCH FUND:

Cash in Bank (Exhibit "C")	\$ 2,587.39
<i>Total Research Fund</i>	2,587.39

TRUST FUND PRINCIPAL ACCOUNT (See Footnote):

Cash on Deposit (Exhibit "D")	\$ 1,169.73
Investments (At Cost):	
United Savings Bonds	
Series F & G (Market Value \$7,843.70)	\$ 7,837.00
Stock Securities (Market Value \$6,329.38)	4,901.41
5% Real Estate Note (Secured by First Deed of Trust)	1,700.00 14,438.41
<i>Total Trust Fund Principal Account</i>	\$15,608.14

TRUST FUND PRINCIPAL ACCOUNT — INVESTMENT INCOME ACCOUNT:
(See Footnote)

Cash on Deposit (Exhibit "E")	\$ 115.75
<i>Total Trust Fund Principal Investment Income Account</i>	\$ 115.75

TRUST FUND ACCUMULATED INCOME ACCOUNT (See Footnote):

Cash on Deposit (Exhibit "F")	\$ 16.38
Investment (At Cost):	
Preferred Stock (Market Value \$1,524.00)	1,790.85
<i>Total Trust Fund Accumulated Income Account</i>	1,807.23

	\$25,552.16

EXHIBIT "A" (Continued)

LIABILITIES AND FUND SURPLUS

GENERAL FUND:

Advance Payment on Dues	\$ 11.00
Fund Balance	5,422.65
<i>Total General Fund</i>	<i>\$ 5,433.65</i>

RESEARCH FUND:

Fund Balance	\$ 2,587.39
<i>Total Research Fund</i>	<i>\$ 2,587.39</i>

TRUST FUND PRINCIPAL ACCOUNT:

Fund Balance, March 31, 1953	\$15,608.14
<i>Total Trust Fund Principal Account</i>	<i>\$15,608.14</i>

TRUST FUND PRINCIPAL ACCOUNT — INVESTMENT ACCOUNT:

Fund Balance:	
Balance, April 1, 1952	\$ 122.00
Deduct — Excess of Income Distribution and Expense over current year's Income (See Exhibit "E")	6.25
Balance, March 31, 1953	\$ 115.75
<i>Total Trust Fund Principal Investment Income Account</i>	<i>115.75</i>

TRUST FUND ACCUMULATED INCOME ACCOUNT:

Fund Balance:	
Balance, April 1, 1952	\$ 1,807.23
Add — Dividend Income on Stock	65.52
	\$ 1,872.75
Deduct — Income Distribution (See Exhibit "F")	\$ 49.14
— Transfer to Trust Fund	
Principal Account	16.38 65.52
Balance — March 31, 1953	\$ 1,807.23
<i>Total Trust Fund Accumulated Income Account</i>	<i>1,807.23</i>
	<u>\$25,552.16</u>

NOTE: Trust Fund Account figures were taken from Trust Agent's report, First and Merchants National Bank of Richmond, and exclusive of cash, were not verified in any manner.

GENERAL FUND

STATEMENT OF CASH RECEIPTS AND DISBURSEMENTS

FOR THE YEAR ENDED MARCH 31, 1953

EXHIBIT "B"

BALANCE ON DEPOSIT — APRIL 1, 1952: \$ 4,660.13

RECEIPT:

Revenues:

Dues:

Regular Members	\$ 1,962.00
Collegiate Members	96.00
Contributing Members	370.00
Sustaining Members	210.00
Life Membership (Paid on Account)	25.00
Delinquent Dues for Prior Years collected	232.00 \$ 2,895.00

Gifts, Grants and Bequests:

Virginia Junior Academy of Science	\$ 370.00
--	-----------

Non-Revenue:

Advance payment of dues	\$ 11.00
Special Contributions toward Annual Meeting May 1953:	
To Science Talent Search	1,525.00
Collections from sales of booth space for May 1953 meeting	90.00
Collections from sales of booth space for May 1952 meeting — shown below as deduction of meeting expenses, \$330	
Dividend form stock investments	13.75
<i>Total Receipts</i>	<i>1,639.75</i>
	<i>4,904.75</i>
	<hr/>
	<i>\$ 9,564.88</i>

DISBURSEMENTS:

American Association for Advance- ment of Science Meeting	\$ 200.00
Junior Academy of Science	439.20
Annual Meeting Expenses:	
Total Expenses Incurred and	

Paid	\$ 411.93
Proceeds from Meeting Activities	330.00
	81.93
Miscellaneous and General Expenses (Schedule "T")	292.37
Postage and Express Expense	105.52
Printing Expense	138.46
Science Talent Search	1,063.00
Stationery, Supplies and Stenographic Services	46.50
The Virginia Journal of Science (Schedule "2")	2,036.00
Dr. E. C. L. Miller Award	50.00
Investments in Corporate Stocks	2,445.95
<i>Total Disbursements</i>	6,898.93
BALANCE — MARCH 31, 1953 (Exhibit "A")	\$ 2,665.95

Consisting of:

Cash on Deposit First and Merchants National Bank of Richmond — Checking Account:	
General Fund	\$ 1,433.29
James River Project	45.66
Science Talent Search	1,187.00
	<hr/>
	\$ 2,665.95

RESEARCH FUND

STATEMENT OF CASH RECEIPTS AND DISBURSEMENTS FOR THE YEAR ENDED MARCH 31, 1953

EXHIBIT "C"

BALANCE OF DEPOSIT — APRIL 1, 1952:	\$ 1,810.62
Receipts:	
Revenues:	
Income from Trust Investments	\$ 649.27
Gift, Grants and Bequests	656.50
<i>Total Receipts</i>	1,305.77
	<hr/>
	\$ 3,116.39

DISBURSEMENTS:	
Grants-In-Aid Awards	\$ 527.50
Miscellaneous and General Expenses	1.50
<i>Total Disbursements</i>	529.00
BALANCE ON DEPOSIT — MARCH 31, 1953 (Exhibit "A")	\$ 2,587.39

Consisting of:

Cash on Deposit First and Merchants National Bank of Richmond - Checking Account	\$ 2,587.39
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TRUST FUND PRINCIPAL ACCOUNT -

PRINCIPAL CASH ACCOUNT

STATEMENT OF CASH RECEIPTS AND DISBURSEMENTS

FOR THE YEAR ENDED MARCH 31, 1953

EXHIBIT "D"

BALANCE - APRIL 1, 1952:	\$ 669.73
--------------------------------	-----------

RECEIPTS:

Proceeds from Shepperson Deed of Trust Note, Instal'ment paid August 28, 1952	500.00
--	--------

BALANCE - MARCH 31, 1953 (Exhibit "A")	\$ 1,169.73
--	-------------

Consisting of:

Cash on deposit with Depository Bank of the Trust Agent, First and Merchants National Bank of Richmond	\$ 1,169.73
---	-------------

TRUST FUND PRINCIPAL ACCOUNT -

INVESTMENT INCOME CASH ACCOUNT

STATEMENT OF CASH RECEIPTS AND DISBURSEMENTS

FOR THE YEAR ENDED MARCH 31, 1953

EXHIBIT "E"

BALANCE -- APRIL 1, 1952:	\$ 122.00
---------------------------------	-----------

RECEIPTS:

Revenue:

Dividends on Stock Investments	\$ 335.00
Interest on Federal Government Bonds	195.00
Interest on Real Estate First Deed of Trust Note	97.50
Transfer from Trust Fund Accumulated In- come Account	16.38

Total Receipts	643.88
----------------------	--------

\$ 765.88

DISBURSEMENTS:

Remittance to Virginia Academy of Science —

Research Fund	\$ 600.13
Trust Agent's Commission	50.00

Total Disbursements 650.13

BALANCE — MARCH 31, 1953 (Exhibit "A") \$ 115.75

Consisting of:

Cash on deposit with Depository Bank of the Trust Agent,

First and Merchants National Bank of Richmond	\$ 115.75
---	-----------

TRUST FUND ACCUMULATED INCOME — CASH DISCOUNT

STATEMENT OF CASH RECEIPTS AND DISBURSEMENTS

FOR THE YEAR ENDED MARCH 31, 1953

EXHIBIT "F"

BALANCE — APRIL 1, 1952: \$ 16.38

RECEIPTS:

Dividends on Stock Investments	65.52
.....	
.....	\$ 81.90

DISBURSEMENTS:

Remittances to Virginia Academy of Science —

Research Fund	\$ 49.14
Transfer to Trust Fund Principal Account	16.38

Total Disbursements 65.52

BALANCE — MARCH 31, 1953 (Exhibit "A") \$ 16.38

Consisting of:

Cash on Deposit with Depository Bank of the Trust Agent,

First and Merchants National Bank of Richmond	\$ 16.38
---	----------

GENERAL FUND

SCHEDULE OF MISCELLANEOUS AND GENERAL EXPENSES
FOR THE YEAR ENDED MARCH 31, 1953

SCHEDULE "1"

Auditing and Tax Service	\$ 212.00
Post Office Box Rental	25.00
Virginia Corporation Registration Fee and Franchise Tax	5.00
Fidelity Bond Insurance	12.50
Expenses paid as reimbursement to the office of the Academy's President	14.98
Telephone and Telegraph	16.64
Miscellaneous	6.25
<i>Total (Exhibit "B")</i>	<u>\$ 292.37</u>

ANALYSIS OF COLLECTIONS FOR AND REMITTANCE TO
 THE VIRGINIA JOURNAL OF SCIENCE
 FOR THE YEAR ENDED MARCH 31, 1953

SCHEDULE "2"

BALANCE — APRIL 1, 1953	\$	16.00
COLLECTIONS:		
Membership Dues at \$2.00 each:		
749 Paid during current year		1,498.00
66 Delinquent dues collected		132.00
2 Prepaid dues of previous year transferred to cur- rent year		4.00
20 Gratuitous subscriptions to Patrons, Honorary and Life Members		40.00
Collegiate Membership Dues at \$1.65 each:		
45 Paid during current year		56.25
	(1)	\$ 1,714.25
REMITTANCES:		
April 15, 1952	\$	138.00
June 27, 1952		6.25
July 30, 1952		56.00
September 12, 1952		20.75
March 3, 1953		1,752.50
March 11, 1953		24.25
March 20, 1953		27.50
March 25, 1953		10.75
	Total Remittances (Exhibit "B")	(2) \$ 2,036.00
BALANCE — MARCH 31, 1953 (1) minus (2)		
(Overpayment)	\$	321.75

REPORT OF THE LONG RANGE PLANNING COMMITTEE

No new projects were initiated by the Committee during the past Academy year; hence, this is a report on the projects currently being developed.

The Committee on Science Teaching in the Secondary Schools of Virginia completed its studies and requested to be discharged. The members of the Committee, however, agreed to the suggestions that it be continued on inactive status for another year. In the January issue of the *Journal*, the Chairman, Dr. Francis G. Lankford, Jr., published a report

on the preliminary findings of the Committee. His final report is included below.

This committee has completed a superior study of a complex subject and appreciation is herewith expressed; special commendation should be given to the Chairman, and to Professor Percy Warren, Mr. John B. Chase, and Mr. Philip Peterson for their detailed investigations.

Dr. John T. Baldwin, chairman of the *Committee on the Dismal Swamp Project* has presented the following statement concerning the status of the book being written about the Swamp:

"Considerable progress has been made on the *Dismal Swamp Project* during the past year. Eleven collaborators were selected to write a popular book on the Swamp. Various of them have paid one or more visits to the area for collecting and study purposes. Two of them have submitted their manuscripts to the editor; others are known to be actively at work on their segments of the proposed book."

A brief meeting of the *Long Range Planning Committee* was held on May 7 at Virginia Military Institute.

MARCELLUS H. STOW

REPORT OF THE RESEARCH COMMITTEE

The 1953 J. Shelton Horsley Research Award was won by Mr. Stephan Berko and Dr. Frank L. Hereford, Department of Physics, University of Virginia, for their excellent joint paper "Deflection of High Energy Electrons in Magnetized Iron."

During the year several requests for Research Grants-in-Aid were approved. Including two actually approved at the 1952 Annual Meeting, four grants were made for studies connected with the Dismal Swamp Project. In each of these four cases the Committee approved the award of funds, up to the requested amounts, for travel and field expenses through June 30, 1953 (and through August 31, 1953 in Dr. Stow's case), payable upon the submission of expense accounts to the Secretary of the Academy. Persons extended these grants, with their planned study, the requested grant, and (in parentheses) the amount spent at the time of this report follow:

1. J. T. Baldwin, Jr., College of William and Mary. Field expenses to study the plants and vegetation of the Dismal Swamp. \$200.00 (\$200.00).

2. J. J. Murray, Lexington. Field expenses to study the birds of the Dismal Swamp. \$100.00 (\$57.50).

3. Marcellus Stow, Washington and Lee University. Field expenses to study the geology of the Dismal Swamp. \$170.00 (\$100.00).

4. C. O. Handley, Jr. Field expenses to make a survey of mammals of the Dismal Swamp. \$100.00 (\$).

Three other Grants-in-Aid were awarded during the year. These were to:

5. K. E. Hyland, Jr., Christchurch School. Expenses, supplies, and equipment to study the life cycle and parasitic habits of the chigger mites found on amphibians. \$120.00.

6. Frank R. Burleson, Virginia Polytechnic Institute. Grant to be used toward purchase of a Beckman pH meter to be used in study of algal flora of soils. \$150.00.

7. John B. Burch, University of Richmond. Field expenses in connection with a study of freshwater Mollusca of Hanover, Henrico, and Chesterfield Counties.

WALTER S. FLORY, JR.

REPORT OF

THE COMMITTEE ON FINANCE AND ENDOWMENT

The Committee on Finance and Endowment met on April 29 and carefully considered the finances of the Virginia Academy of Science. The audit, which had been studied by each member of the Finance Committee, was approved.

After going over the expenses for the past year, the Committee proposed the following budget for the coming year:

BUDGET

VIRGINIA ACADEMY OF SCIENCE

	Budget for 1952-53	Spent in 1952-53	Proposed for 1953-54
A. A. A. S. Meeting	\$125.00	\$125.00	\$125.00
E. C. L. Miller Award	50.00	50.00	50.00
Junior Academy of Science and			
Science Talent Search	225.00	225.00	225.00
Meeting expenses	25.00	—	25.00
Audit and tax services	170.00	212.00	200.00
Premium and treasury bond	12.50	12.50	12.50
Stationery supplies and			
stenographic services	125.00	46.00	75.00
Postage and express charges	75.00	105.00	125.00
Travel expenses for representatives			
to meetings	250.00	75.00	200.00
Subscriptions to Journal of Science			
for life members	40.00	40.00	46.00
Addressograph service	—	—	75.00
	\$1197.50	\$890.50	\$1158.50

It is recommended by the committee that the Research Fund be turned over to an agency account at the First and Merchants National Bank in Richmond. It is our suggestion that \$500.00 be kept available at all times for immediate use for grants and other requisitions and that the remaining money, some of which is now lying idle, be invested in stocks as recommended by the Trust Department of that bank. It is felt that in so doing a better income would be derived for the use of the Research Committee, and that this arrangement will markedly reduce the audit expenses of the Academy as it will leave only the general fund to be audited.

The Committee also considered some new method of financing the Junior Academy of Science and the Science Talent Search. It is hoped within the next year a more reasonable arrangement, possibly through an endowment fund, will be worked out to finance these two very important activities.

GUY W. HORSLEY

REPORT OF THE COMMITTEE ON THE VIRGINIA JUNIOR ACADEMY OF SCIENCE

The Virginia Junior Academy of Science, in keeping with its purpose of promoting and maintaining interest in science among secondary school students, has carried out the following activities during 1952-53:

PUBLICITY

1. The *Junior Science Bulletin*, a four-page publication, was initiated. The publication was made possible by a contribution of \$200 by the American Tobacco Research Laboratory. The printing has been done by the Newport News High School print shop under the supervision of Miss Susie V. Floyd and the Newport News Science Club. Three issues, (approximately 1600 copies per issue) have been mailed to science teachers, committee members, to Council members, and to firms that have given their financial support to the work done with the Juniors.
2. One issue of the *Virginia Journal of Education* was largely devoted to special articles, notices, and photographs concerning the work of the V. J. A. S. One issue of the *Virginia Education Bulletin* was entirely devoted to Science and Mathematics and contained special notices concerning the V. J. A. S.
3. Announcements concerning V. A. S. work and the Speakers and Counsellors Bureau were made at the Science Teachers' Section meeting of the Virginia Educational Association, at each District meeting of the V. E. A., and at the annual meeting of the Virginia Teachers' Association.

4. Direct correspondence with active clubs amounted to 538 letters and four sets of mimeographed communications.

SOLICITATION OF WORKING FUNDS

1. Funds were solicited from industrial firms to defray the expenses of the work sponsored by the Virginia Academy of Science among secondary school students. A total of \$1485 was raised for this purpose from the following 19 firms:

Allied Chemical and Dye Corporation
American Cyanamid Company
American Tobacco Research Laboratory
American Viscose Corporation
The Chesapeake Corporation of Virginia
E. I. duPont de Nemours and Company, Inc.
Mrs. Jessie Ball duPont
Experiment, Incorporated
Fisher Scientific Company
The Lane Foundation
Monsanto Chemical Company
Newport News Shipbuilding and Dry Dock Company
Phipps and Bird
Reynolds Metals Company
West Virginia Pulp and Paper Company
Hastings Instrument Company
Virginia Power and Electric Company
Chesapeake and Potomac Telephone Company of Virginia
Union Carbide and Carbon Corporation

TEACHER - SPONSOR SCHOLARSHIPS

1. Summer scholarships made available by the University of Virginia and the College of William and Mary as awards to two outstanding Teacher-Sponsors were increased from \$100 to \$200.

AFFILIATION OF CLUBS AND INDIVIDUAL MEMBERSHIP

1. Charters and membership cards were issued to sixty-five clubs with an individual membership of approximately 1200. Fifty-four of the clubs were new affiliates.

SCIENCE REGIONAL OPEN HOUSES

The Committee asked five colleges to sponsor Open Houses. Emphasis was to be placed on greater uniformity in competition, on exhibits, lectures, tours, etc. These schools did an excellent job. A total of 118 student exhibits were on display; 49 individual and 4 club exhibits were qualified for entry at the May meeting of the V. J. A. S.

PROGRAM FOR MAY MEETING

1. Exhibits were left on display longer to allow a better length of time for judging.
2. Five students were selected to explain and demonstrate their projects before the Junior Assembly.
3. The General Electric "House of Magic" show was scheduled for appearance.
4. A guest speaker, Dr. John Fisher, Metallurgy Research Department, General Electric Company, spoke on "CRYSTAL GROWTH".

AWARDS

E. C. L. Miller Award: Honors were given equally to Newport News Science Club, Miss Susie V. Floyd, Sponsor, and to Buckingham Central Science Club, Mr. O. P. Sadler, Sponsor.

First Place — Club Exhibit: Newport News Science Club, Miss Floyd, Sponsor.

Second Place — Club Exhibit: Madison Heights Science Club, Mrs. Kate McDermott, Sponsor.

Third Place — Club Exhibit: Lane Science Club, Miss Martha Duke, Sponsor.

First Place — Individual Exhibit: Jane Black, James Monroe H. S., Fredericksburg.

"Four Inert Minerals From the Potomac Region"

Second Place — Individual Exhibit: Doris Hermes, Martinsville H. S., Martinsville.

"Dyeing of Orlon"

Third Place — Individual Exhibit: Eleanor O'Meara, Lane H. S., Charlottesville.

"Colors Caused by the Polarization of Light"

Honorable Mentions — Individual Exhibits:

Patricia Ann Smith, Radford H. S., Radford
Floyd Wilson, Booker T. Washington H. S., Norfolk
Glenn Shepherd, Warwick H. S., Warwick
Frank Daniel, Lane H. S., Charlottesville
Merle Mitchell, Booker T. Washington H. S., Norfolk

Honorary Student Memberships:

A. A. A. S.: Rosser Rudolph, Washington-Lee H. S., Arlington
Merle Mitchell, Booker T. Washington H. S., Norfolk
V. A. S.: Claude Barfield, Newport News H. S., Newport News
James Hayes, Booker T. Washington H. S., Norfolk

Teacher — Sponsor Scholarships:

College of William and Mary — L. W. Jarman, Thomas Jefferson H. S., Richmond

Alternate — O. P. Sadler, Buckingham Central H. S., Buckingham
University of Virginia — Miss Martha Duke, Lane H. S., Charlottesville

Alternate — Miss Delores Hoback, Martinsville H. S., Martinsville

REPORT OF

THE EIGHTH VIRGINIA SCIENCE TALENT SEARCH

The following is a summary of the Eighth Virginia Science Talent Search, an affiliate of the Twelfth National Search:

547 seniors from 64 secondary schools requested examination papers (a tie with the previous record).

143 completed all papers and thus became official contestants in the Search (a new record).

One of these was named National Winner, and seven won National Honorable Mention. (Names given below.)

Forty-nine of the 143 were chosen as Virginia finalists on the basis of their written records, *i.e.*: (1) science aptitude examinations; (2) high school scholastic record; (3) teacher's analysis and recommendations; (4) science project and project report. All finalists and sponsors were invited to the annual meeting of the Academy. Most attended, and part of their expenses were paid from the funds mentioned in the Virginia Junior Academy Committee report.

At the meeting, finalists were interviewed by panels of judges. The results of these interviews were combined with the written records to select eighteen Winners, the other thirty-one automatically becoming Honorable Mentions.

WINNERS

** National Winner

* National Honorable Mention

* Margaret S. Anderson	Norview H. S.	Norfolk
Claude E. Barfield	Newport News H. S.	Newport News
* Harvey J. Charlton	Buckingham Central	Buckingham
* Paul C. Desper	Wilson Memorial H. S.	Fishersville
Courtney S. Jones	Hampton	Hampton
Robley J. Light	William Fleming	Roanoke
Paul D. Lindsey	John Marshall	Richmond
Sylvia D. Mathis	Stuart Hall	Staunton
Raphael C. Myers	Norview	Norfolk
William K. Nelson	John Marshall	Richmond

William M. Pardue	Blacksburg	Blacksburg
William E. Parsons	Jefferson Senior	Roanoke
William E. Shawcross	Granby	Norfolk
Henry M. Snell	Thomas Jefferson	Richmond
Virginia L. Stauss	Mount Vernon	Alexandria
Freddie Ray Stone	Wilson Memorial	Fishersville
Helen B. Stone	Thomas Jefferson	Richmond
George Marvin Tatum, Jr.	Thomas Jefferson	Richmond
Thomas G. Teates	Warren County	Front Royal
Suzanne Tully	Thomas Jefferson	Richmond
Gail P. Williams	Hampton	Hampton
William F. Willoughby	Christchurch	Christchurch
* James A. Hayes	B. T. Washington	Norfolk
Jerry B. Hibbitts	Dickenson	Clintwood
James M. Howell	Radford	Radford
Francis Hull	Newport News	Newport News
* F. Wendell Johnson	Hermitage	Richmond
Kenneth T. Lassiter	Hermitage	Richmond
* * Merle A. Mitchell	B. T. Washington	Norfolk
* Kenneth A. O'Beirne	Andrew Lewis	Salem
* Rosser A. Rudolph	Washington-Lee	Arlington
Francis W. Sheild	Hampton	Hampton
Louis W. Spradlin	Andrew Lewis	Salem
Thomas A. Stansell	Hermitage	Richmond
John L. Tiller, Jr.	John Marshall	Richmond
Walter V. Weyhmann	Jefferson Senior	Roanoke

HONORABLE MENTION

John C. Alderman, Jr.	Lane	Charlottesville
John M. Austin	Buckingham Central	Buckingham
Edward A. Brewton	Granby	Norfolk
Edwin T. Chapman	Newport News	Newport News
Epsey M. Cooke	Stuart Hall	Staunton
Colleen G. Cord	Radford	Radford
E. Donald Crewdson	Warren County	Front Royal
Frank D. Daniel, Jr.	Lane	Charlottesville
Charles W. Dyke	Hermitage	Richmond
James A. Eller	Norfolk Catholic	Norfolk
Jonathan T. Howe	Granby	Norfolk
Thomas W. Imel	Hermitage	Richmond
William H. Jago	William Fleming	Roanoke

The Chairman is happy to have this opportunity to make several grateful acknowledgments:

To the Leander McCormick Observatory of the University of Virginia for clerical assistance;

To the presidents and officers of Virginia colleges and universities for their interest in revising the list of scholarships offered;

To the officers of the Academy for much sound advice and encouragement;

To the members of the Committee and to the judges for their cheerful cooperation.

EDWARD R. DYER, JR.

REPORT OF

THE COMMITTEE ON ACTIVITIES FOR COLLEGIATE MEMBERS

This year's committee met with the same lack of response reported by its 1951-1952 predecessor. Early in the college year the chairman sent letters to seventeen Academy members at institutions scattered around the State. These letters suggested ways of trying to develop among college students an interest in Academy affairs, including attendance at and participation in the May meetings. The response was disappointing. We received only four replies, three written and one verbal, none of which was encouraging. Two stated that they found only an apathetic attitude among the students. Graduate students seemed to appreciate the value of Academy work, but with few exceptions, according to these correspondents, their undergraduates seemed satisfied to do the minimum work required to get by, and were too busy with their own fraternity and other extracurricular activities to bother with anything more serious. Apparently having his science club listed as affiliated with the Virginia Academy of Science does not seem to the average student to carry with it any particular advantage.

The interested high school student is served by the Junior Academy. The graduate students fall more naturally into the senior Academy and do not need the encouragement of this committee. With the students between high school and graduate school we must again report failure. If this committee is to continue to exist, perhaps it should be smaller and made up of men who have the time to travel around the State visiting the science clubs in our colleges and talking directly to the students. Perhaps also the purpose of the committee should be reviewed in Council or by the President's Advisory Committee in order to determine its function and to give it specific assignments other than to secure affiliation of science clubs as student chapters in the Academy.

W. SCHUYLER MILLER AND ROBERT P. CARROLL

REPORT OF THE COMMITTEE ON MEMBERSHIP

During the past year, from May 1, 1952, to May 1, 1953, the Academy has added 151 new members classified as follows:

Regular and contributing members	109
Student members	42
Total	151

The total membership of the Academy in good standing as of May 1, 1953, is as follows:

Regular, contributing, and sustaining	910
Student	63
Total	973

The low figure of 973 members as compared with membership of 1204 in 1949-1950 and 1194 in 1950-1951 is explained largely by the fact that all members in arrears according to the terms of the new constitution have been dropped from the rolls.

It is the Committee's feeling that since the Academy often speaks for science in Virginia, a larger membership is necessary and desirable. It is felt that a total membership goal in the neighborhood of 1500 active members should be set for the next two-year period. The past accomplishments and future aims and objectives should be brought forcefully to the attention of non-members interested in science in Virginia.

HENRY LEIDHEISER, JR.

REPORT OF THE JAMES RIVER PROJECT COMMITTEE

The report of the Committee for the year 1952-53 consists of a financial statement concerning sale of the monograph on "The James River Basin — Past, Present and Future."

Summary as of April 30, 1953

Total copies distributed as of April 30, 1952	484
Balance on deposit, Peoples National Bank, Lexington, Va. as of April 30, 1952	1531.90
Complimentary copies distributed between May 1, 1952 and April 30, 1953	10
Sold, payment received at \$6.00 between May 1, 1952 and April 30, 1953	16
96.00	
Sold, payment due, between May 1, 1952 and April 30, 1953	1
6.00	

Total distributed between May 1, 1952 and April 30, 1953	27
Total cash received between May 1, 1952 and April 30, 1953	96.00
Deposited in bank between May 1, 1952 and April 30, 1953	126.00
Expenditures charged to Monograph account between May 1, 1952 and April 30, 1953	0.00
Net balance in Peoples National Bank from sales May 1, 1952 to April 30, 1953	126.00
<i>Total balance in Peoples National Bank from sales May 11, 1950 to April 30, 1953</i>	<i>1657.00</i>
<i>Total copies distributed May 11, 1950 to April 30, 1953</i>	<i>511</i>

MARCELLUS H. STOW

REPORT OF THE COMMITTEE ON RESOURCE-USE EDUCATION

The Resource-Use Education Committee had an active year.

The Committee felt that if resource-use education was to find its rightful place in Virginia, past recommendations to the Academy should be brought before the State Board of Education. Through the support of President Lloyd C. Bird and other academy members and the cooperation of Dr. Dowell Howard, State Superintendent of Public Instruction, such a meeting was arranged on February 26. The subject of conservation education in Virginia schools and colleges was discussed and the following recommendations made:

1. *Coordination of Resource-Use Education at State Level and Inter-Agency Cooperation:*

The Committee recommends the appointment of a *well-trained, full-time* supervisor of conservation education studies in the office of the State Board of Education to coordinate and advance all resource education effort at the state level.

2. *Teacher training:*

- a) Require all state-supported teacher training institutions to offer an accredited conservation course to prospective Virginia teachers. Require one full conservation course of all teachers before certification.
- b) Have the supervisor of conservation education studies initiate a *pre-service* teacher training program with emphasis on the conservation content of such courses as general science, biology, chemistry, physics, geology, sociology, economics, geography, and history. All resource-use agencies should be asked to help.

- c) Have the same supervisor initiate a broad program of *in-service* teacher training making use of workshops and other proven teaching media, to show how conservation can be woven into existing courses of instruction.
3. *Teaching Materials:*
The Committee recommends that greater stress be given to the preparation and augmentation of teaching materials on resource conservation. Some material would be aimed at teachers, some at the grades. In the preparation of this material, inter-agency help, advice, and review should be asked for. Adequate material is lacking now.
4. *Resource-use Instruction in Elementary and Secondary Schools:*
The Committee urges that greater emphasis be placed on conservation in all grades; that existing curricula be revised and brought up to date, and that more resource-use fundamentals be integrated in all course work.

The Committee undertook the responsibility of sponsoring a Resource-Use Education symposium at the annual meeting in Lexington, May 8. It was endorsed by the president and supported by many of the sections. Alfred E. Wingo of the State Board of Education was named moderator; twelve experts representing various resource agencies and educational institutions were asked to serve on the panel.

J. J. SHOMON

REPORT OF THE COMMITTEE ON VIRGINIA FLORA

The individuals of the committee have been variously active in relation to the state flora. Dr. Patterson continues his studies of the mosses. Miss Artz continues her investigations of the Massanutten region. Mr. Mason has continued his photography and has given a number of illustrated lectures relative to the kinds of native plants and their wise use, in an effort to teach the conservation of useful and infrequent species.

Mr. H. A. Allard of Arlington, now a retired plant physiologist of the United States Department of Agriculture, is making a detailed study of the flora of the Triassic area in Northern Virginia. Mr. E. C. Leonard, of the United States National Herbarium, is cooperating with him. Remembering their contributions to the state flora in their studies of Bull Run Mountain in Fauquier and Prince William counties, we can anticipate an important contribution from them relative to the Triassic area. Not only should this be of floristic value but should also have an ecological bearing.

Mr. Massey, with the cooperation of members of the committee and others, has been active in developing an annotated check list of the plants of the State. A preliminary check list covering 26 families was reported last year. The check list is to be further developed and carried to completion. There being considerable interest in the native orchids, a compete check list has been prepared for this one family. This list will be

printed in the near future. These lists report occurrences in the State by physiographic provinces and counties. A paper on the aquatic and semi-aquatic plants in Virginia is nearing completion. This paper will include habitat, distribution, and economic importance of the plants included. Two papers have been published by Massey in *Virginia Wildlife*: "Native Plants and Their Wise Use" appeared in the May 1952 issue; and "Evergreens Native in Virginia," in the December 1952 issue.

A. B. MASSEY

REPORT OF THE SPEAKERS AND COUNSELLORS COMMITTEE

The Speakers and Counsellors Committee, during the year, prepared a list of speakers for each section of Virginia. Regional chairmen were selected so that the arranging for speakers could be arranged locally. The list of speakers and an outline of the committee's program was put into the hands of every principal and school superintendent in Virginia through the cooperation of D. J. Howard, Superintendent of Public Instruction and R. E. Reid, Assistant Superintendent of Public Instruction. Through the cooperation of Mrs. B. J. Heatwole, Chairman of the Junior Academy of Science, the program was called to the attention of all science teachers in Virginia. Mr. A. L. Wingo, a member of the committee and Supervisor of Research, State Board of Education, met with both the white and colored high school principals of the State and called the services of the Speakers and Counsellors Committee to their attention.

In the area serviced by Dean Warren and where Mrs. Heatwole could extend a helping hand, the response was gratifying. In other areas, the response was less than an average of two speakers per district serviced by the various regional chairmen.

It is the suggestion of the committee that the committee be continued for one year to answer any requests resulting from the publicity given this year and then be discontinued.

S. S. OBENSHAIN

REPORT OF THE RESOLUTIONS COMMITTEE

BE IT RESOLVED, that the Virginia Academy of Science record its sincere appreciation to the host for the thirty-first annual meeting, the Virginia Military Institute, and its Superintendent, General William H. Milton.

BE IT FURTHER RESOLVED, that the Virginia Academy of Science express its heartfelt thanks and commendation to the Local Committee on Arrangements under the able leadership of Colonel S. M. Heflin, for making possible a most successful meeting.

BE IT FURTHER RESOLVED, that the Academy express its deep regret at the temporary absence from the State of our Secretary Emeritus,

Dr. E. C. L. Miller, who has been present at all former meetings of the Academy since its formation in 1923.

E. S. HARLOW, for
RUSKIN FREER, *Chairman*, and
DEAN IVEY LEWIS

REPORT OF THE COMMITTEE ON PLACE OF MEETING FOR 1954

This committee is pleased to report that Mr. Colgate Darden, president of the University of Virginia, has extended to the Academy a cordial invitation to hold its annual meeting for 1954 at the University of Virginia, Charlottesville. It is our recommendation that the Academy accept this invitation.

I. G. FOSTER

REPORT OF THE COMMITTEE ON LOCAL ARRANGEMENTS

The Committee on Local Arrangements for the thirty-first annual meeting of the Virginia Academy of Science was drawn from the faculty of the host institution — the Virginia Military Institute. The meeting was held on May 6, 7, 8, and 9, 1953.

The officers and Council of the Academy met with the Local Committee on October 12, 1952; and it was decided to abolish the annual banquets for both the Junior Academy and the Senior Academy and to have the General Electric Company bring its "House of Magic" Show to the Junior Academy meeting on Thursday, May 7, at 8:30 P.M. and have Dr. Hubert N. Alyea of Princeton University give his famous lecture on Atomic Energy on Friday, May 8, at 8:30 P.M. This was done; and Dr. John C. Fisher of the Metallurgy Department of the General Electric Company addressed the Junior Academy on Friday, May 8, at 11:30 A.M.

Meeting rooms were equipped and assigned to the twelve Academy sections, one section in Maury-Brooke Hall, one section in Nichols Engineering Hall, and ten sections in Mallory Hall. Due to the size of these rooms, all sections had ample space, and they were not crowded. The record shows that 494 senior members registered and that 144 junior members registered during the meeting.

There were 45 Junior Academy exhibits, and they were housed in three large adjoining laboratories in Mallory Hall. There were eight commercial exhibits and four educational exhibits. They were housed in two large adjoining laboratories in Mallory Hall. The commercial exhibits consisted of the following: A. S. Aloe Company, Carolina Biological Supply Company, American Tobacco Company, Fisher Scientific Company, Phipps and Bird, Cardinal Products Company, Bausch and Lomb Optical Company, and the American Optical Company. The educational exhibitors were Langley Field, Blue Ridge Parkway, Newport News Shipbuilding and Dry Dock Company, and Professor Lowell Heisey of Bridge-

water College. The income from the meeting was much more than sufficient to meet the expenses of the annual meeting of the Academy, and the balance will accrue to the Academy.

The Superintendent and Mrs. Milton held a Reception for the Academy members and guests at Alumni Hall on Friday afternoon from 4:30 P.M. to 6:00 P.M., during which time some three hundred guests were in attendance. A committee of faculty ladies met the visiting ladies and arranged a sightseeing tour during Friday morning, May 8.

The Committee wishes to express its appreciation for the fine cooperation of the section officers before and during the meeting. The Chairman gratefully acknowledges the valuable assistance given him by the Academy officers and sincerely thanks all of the Committee members for their continuous help.

S. M. HEFLIN

A REPORT OF THE COMMITTEE ON SCIENCE TEACHING IN VIRGINIA SCHOOLS

A Committee on Science Teaching in Virginia Schools was created by the Academy late in 1951. Members of the Committee consist of:

Dr. F. G. Lankford, Jr., (Chairman), Department of Education University of Virginia

Dr. Byron M. Cooper, Department of Geology, Virginia Polytechnic Institute

Dr. George Jeffers, Head of the Biology Department of Longwood College

Mr. John B. Chase, Jr., Department of Education, University of Virginia

Dr. James W. Cole, Department of Chemistry, University of Virginia

Dr. Percy H. Warren, Madison College

Dr. William M. Hinton, Professor of Psychology, Washington and Lee University

Mr. F. D. Kizer, Science Faculty of Norview High School

Dr. R. O. Nelson, Superintendent of Schools, Albemarle County, Charlottesville

Three studies have been done for the Committee. One of these was undertaken by Professor Percy Warren of Madison College. It deals with assignments of science teachers, preparation of science teachers, and their reactions to their college preparation. Among Professor Warren's preliminary findings are these:

"It was found that more than 50% of the high schools in Virginia have a minimum science offering of general science, biology and chemistry. Notwithstanding this fact, more than 50% of the teachers who taught one or more classes in science taught only one or two science classes.

More than 60 taught only one science subject and more than 85% of the teachers taught no more than two different subjects in science."

He has collected through questionnaires a great deal of original data which he is now in the process of organizing into a final report. He hopes to be able to complete this study before the end of 1953. He is interested in obtaining further information on teaching personnel through the preliminary annual reports that will be filed with the State Department of Education by high school principals in the fall of 1953.

Mr. John B. Chase has completed his study for the committee on Certification of Science Teachers. His study describes practices in Virginia as well as in other states. It also obtained from Virginia superintendents a description of their practices in employing science teachers and their opinion regarding certification. His report also includes a review of similar studies conducted elsewhere as well as the recommendations of various national committees. He reached the following 11 conclusions:

1. In general, writers feel that state certification requirements are not sufficient to assure competence in subject matter.
2. In general, state requirements for certification do not require the breadth of training that seems to be desirable. A breadth of training was recommended by superintendents of Virginia.
3. State certification requirements should encourage and require training which provides functional, integrated general science courses for the science teacher drawing from chemistry, physics, biology, astronomy, geology and meteorology.
4. State certification requirements should require the prospective science teacher to have introductory courses in at least three major fields of science — biology, chemistry and physics.
5. State certification requirements should require the prospective teacher to have additional courses in biology, chemistry, and physics totaling at least 24 hours in at least one field and at least 18 semester hours in others.
6. Science teacher should be trained and certified to teach at least 3 high school sciences.
7. In Virginia, the vast majority (98.2 percent) of possible science vacancies calls for certification in at least three of the sciences.
8. In Virginia, it seems more desirable for teachers to be trained and certified to teach any of the possible combinations of fields rather than one specific science.
9. A plan for a single endorsement rather than the present plan of separate endorsement was favored and recommended by 55.3 percent of the superintendents reporting.
10. Science teachers should be trained and certified so as to enable them to integrate the various sciences and to show social, economic, and political relationships which exist in scientific development and

- progress. This cannot be accomplished by a series of separate courses alone and calls for further study of the organization and methodology used in science courses on the college level.
11. There should exist a constant and closer working relationship between certification agencies and institutions planning programs the training of teacher of science. Such a task requires the best cooperative effort of all concerned — schools of education, departments of science, scientific organizations and state agencies.

Mr. Philip Peterson has made available to the committee the findings of his Master's thesis completed in 1952 at the University of Virginia. He studied science offerings and student election of science courses in Virginia high schools. Regarding offerings of the Virginia high schools, Mr. Peterson found that predominantly the offerings are in general science, chemistry, biology, and physics.

Courses in general science have been commonly established at the seventh, eighth, and ninth grade levels, and pupil enrollment in these courses were generally restricted to these grade levels. Biology enrollments came principally from the tenth grade, although some ninth grade and eleventh grade pupils enrolled in the course. Physics and chemistry enrollments were predominantly from the eleventh and twelfth grades, where these two courses have been commonly offered.

Using a sample of Virginia high schools, Mr. Peterson found that the most frequent combination of science courses elected by Virginia high school students while in high school is one including a course or courses in general science and a course in biology. The second most frequent combination was a course or courses in general science together with biology or chemistry.

Mr. Peterson also examined the enrollments in science courses in a sample of Virginia accredited high school for the single year of 1950-51. He found that in 1950-51 general science was the most widely elected science course in high school. The total enrollment in this subject was 13,068 pupils, or 35.8 percent of the total sample school enrollment. Biology was the next most widely elected science with an enrollment of 6,050 pupils or 16.6 percent of the total school enrollment. Chemistry was third in number of enrollments, with 2,069 pupils electing the subject, or 5.7 percent of the total sample school enrollment. Few students elected physics. Only 569 pupils, or 1.6 percent of the total sample school enrollment, elected that science.

In every science course two or three textbooks were used predominantly. The science textbooks most often used by pupils in general science classes were the Wood and Carpenter *Our Environment* series; Smallwood, *et al.*, *New Biology* by pupils taking biology; Jaffe, *New World of Chemistry* by students taking chemistry; Fuller, *et al.*, *First Principles of Physics* by pupils taking physics.

Recommendations of the Committee

1. Our committee recommends that the Academy continue such a committee (not necessarily the same personnel) until Professor Warren's study is completed and a final report can be made.
2. Our committee recommends that the President of the Virginia Academy of Science and Chairman of Long Range Planning Committee approach Superintendent of Public Instruction Dowell Howard to ask him to obtain further data on science teaching personnel which Professor Warren needs in the completion of his study.
3. The committee recommends that Mr. Chase submit to the *Virginia Journal of Science* a paper dealing with his study on Certification of Science Teachers.
4. The committee suggests that the Virginia Academy of Science undertake to get before the State Board of Education some constructive proposals for improving the certification of science teachers in Virginia.

F. G. LANKFORD, JR.

REPORT OF THE VIRGINIA INSTITUTE FOR
SCIENTIFIC RESEARCH

The Research Institute is in its fourth year, and although much remains to be done, it is believed that high quality research is now being carried out on important problems with first-class equipment. All of the major items of equipment, for which special funds were raised during the past two years, have been purchased and installed. They consist of an X-ray diffraction unit, an ultracentrifuge, and an electron microscope with an electron diffraction attachment. These instruments greatly increase the range and accuracy of studies which can be carried out at the Institute.

The research studies can be classified in three main groups: the surface chemistry of metals, including catalysis, corrosion, and electrochemical properties; the preparation of large metal crystals of special shapes and orientations; and the determination of molecular weights with the aid of the centrifuge. Under the heading of surface chemistry the study of the mechanism of hydrocarbon synthesis (manufacture of artificial gasoline) is being continued for a large oil company. Another project, on the influence of crystal face on the corrosion of metals, is being carried out for another sponsor. A study of the electrochemical properties of the wonder metal, titanium, is being made for a government agency with a view to finding a method of electroplating this increasingly important material. The X-ray unit is used for determining the structure and orientation of the surface crystals, and the electron microscope, with a magnifying power of 100,000, is used to examine the surface changes during these processes. The preparation of large metal crystals for other research laboratories has greatly increased in scope and complexity during the past year, and the Institute has more orders for crystals than it can

conveniently take care of. Studies with the ultracentrifuge during the past year have consisted largely of determining the molecular weights and sizes of large protein molecules obtained from a farm product and used in the manufacture of synthetic textiles. Preliminary studies were carried out on the molecular weights of some of the components of tobacco. Studies will soon be started on the cholesterol content of blood in relation to hardening of the arteries in humans. Several miscellaneous studies which do not come under the above headings have been made. One of these is concerned with the influence of crystal face on the photographic properties of silver chloride and is being conducted for the Air Force.

The operating income for the year of 1952, including \$28,000.00 raised for the purchase of special equipment, was \$90,311.19. There are sixteen people employed at the Institute, some of them working part time. With the increasing business of the Institute the administrative duties have greatly increased, and Mr. Robert Kean, the secretary, and Mr. Henry Leidheiser, the laboratory manager, have done a fine job in keeping the business in order. The research staff has also discharged its duties with distinction.

ALLAN T. GWATHMEY

REPORT OF THE VIRGINIA JOURNAL OF SCIENCE

The Journal had a very successful year, as the attached financial statement will show. We were able to get a favorable two-year contract with the Giles County Virginian. Mr. M. D. Coe, editor of the Giles County Virginian, is taking a personal interest in the Journal, and all indications point to a better Journal in the next few years.

We have been very fortunate in getting lead articles from some of the nation's foremost scientists. Dr. Arthur Bevan, Illinois State Geological Survey, prepared the feature article for the Section of Geology; Dr. Ernest Hauser, Massachusetts Institute of Technology, prepared the feature article for the Section of Chemistry; and Dr. M. J. Zucrow, Purdue University, prepared the feature article for the Section of Engineering.

The Section of Engineering, the Section of Geology, and the Section of Medical Sciences elected new section editors this year, to serve for five-year terms.

BOYD HARSHBARGER

AUDIT OF THE JOURNAL

Dr. Boyd Harshbarger, Editor
 Virginial Journal of Science
 Blacksburg, Virginia

Dear Dr. Harshbarger:

I am enclosing a copy of the audit report covering the audit which I made of the books of the Virginia Journal of Science.

This audit consisted of a careful check of income and expenditures, bank account (including both checking and savings accounts), advertising account, extra page and reprint accounts.

I found all records to be accurately and satisfactorily maintained and all moneys accounted for.

The enclosed audit statement, which shows a balance of \$3,160.57, includes only the money carried in the checking account at the Farmers and Merchants National Bank, and does not include your savings account, which amounts to \$1,531.44, also at the Farmers and Merchants National Bank. You have in all some \$757.11 in accounts payable, the bulk of this being owed to the Giles County Virginian for printing your January and April Journals. This, of course, will reduce the balance you have on hand by this amount.

I would suggest that again this year some of the balance carried in your checking account be transferred to your savings account, for your operation seems to be such that you will maintain a good working balance in your checking account even if part of the present balance is withdrawn and transferred to savings.

Sincerely,

JOE W. GUTHRIDGE, Auditor

VIRGINIA POLYTECHNIC INSTITUTE

STUDENT ACTIVITIES OFFICE

OPERATION STATEMENT FOR THE FISCAL YEAR

Virginia Journal of Science

May 8, 1952 to April 10, 1953

<i>Receipts: Kind of Receipts</i>	<i>Total for the Year</i>
Academy Subsidy	
Regular members 918 at \$2.00	\$1,836.00
Student members 58 at \$1.25	72.50
Advertising	418.97
Subscriptions	334.44

Extra pages	203.62
Miscellaneous	13.12
Reprints	35.00
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TOTAL OF ALL RECEIPTS	\$2,913.65
<hr/>	
<i>Expenditures: Kinds of Expenditures</i>	<i>Total for the Year</i>
Reprints	\$ 51.22
Printing	933.76
Postage	83.37
Office Supplies	1.50
Miscellaneous	1.97
<hr/>	
TOTAL OF ALL EXPENDITURES.....	\$1,071.72
NET AMOUNT.....	\$1,841.93
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STATEMENT OF CASH ACCOUNT

Balance of cash at beginning of year	\$1,318.64
Add: Total receipts for year	2,913.65
Total cash on hand during year	4,232.29
Deduct: Total expenditures for year	1,071.72
<hr/>	
Balance of cash at end of year	\$3,160.57
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Audited by: Joe W. Guthridge

Date: April 14, 1953

MINUTES OF THE ACADEMY MEETING FRIDAY, MAY 8, 1953

The Annual business meeting of the Academy was held in Room 104, Mallory Hall, Virginia Military Institute, at 8 P.M. President Lloyd C. Bird, presided, and introduced Major-General Milton, Superintendent of the Virginia Military Institute, who welcomed the Virginia Academy of Science on behalf of the host institution. Following his remarks President Bird introduced Dr. Fisher, of the General Electric Company, who addressed the Junior Academy of Science meeting Friday morning; and Dr. Raymond Taylor, Assistant Executive Secretary of the AAAS. President Bird thanked the officers and Committee Chairman for their cooperation during his term of office. Mr. Dyer introduced Merle A. Mitchell of Booker T. Washington High School, Norfolk, who was a National winner in the Westinghouse Science Talent Search. Her essay submitted in this contest was entitled: "Mass Analysis of Crude Oil".

President Bird presented an Honorary membership in the Academy to Justus Cline of Stuart's Draft. Mr. Cline was absent due to illness, and the certificate was given to Marcellus Stow for presentation to Mr. Cline.

The 1953 J. Shelton Horsley award was won by Mr. Stephan Burko and Dr. Frank L. Hereford, Department of Physics, University of Virginia, for their excellent joint paper "Deflection of High Energy Electrons in Magnetized Iron." Walter S. Flory, Jr., Chairman of the Research Committee, made this presentation.

Report of the Resolution Committee was made by Edward Harlow, and was adopted. It was moved, seconded and passed that copy be sent to Dr. E. C. L. Miller.

Report of the Place of Meeting Committee was made by I. G. Foster, Chairman, who read a letter of invitation from Colgate W. Darden, President of the University of Virginia, inviting the Academy to meet at the University in May, 1954. It was accepted unanimously.

Report of the Nomination Committee was made by Paul Patterson, and the following nominees were unanimously elected for the coming year.

Allan T. Gwathmey, President.

E. C. L. Miller, Secretary-Treasurer Emeritus.

Foley F. Smith, Secretary-Treasurer.

Irving G. Foster, President-Elect.

Walter S. Flory, Jr., Elected to Council for a period of five years.

Stanley B. Williams, Elected to Council for a one year term.

President Bird then turned the chair over to the incoming president, Allan T. Gwathmey.

President Gwathmey introduced Professor William Guy, and presented Professor Hubert N. Alyea, of the Frick Chemistry Laboratory, Princeton

University, who gave a highly interesting and entertaining address and demonstration of "Atomic Energy: Weapon For Peace."

The meeting adjourned following Professor Alyea's performance.

FOLEY F. SMITH, *Secretary*

MINUTES OF THE COUNCIL MEETING

OCTOBER 12, 1952, LEXINGTON

The meeting of the Council of the Virginia Academy of Science was held in the library of Mallory Hall, Virginia Military Institute, Lexington, Virginia, October 12, 1952. President Lloyd C. Bird presided at the meeting.

Present were Council members: Walter S. Flory, Jr., Ladley Husted, I. G. Foster, Sidney S. Negus, Marcellus Stow, Paul M. Patterson, Guy S. Horsley, Boyd Harshbarger, President-elect Allan T. Gwathmey, and Foley F. Smith. Colonel S. M. Heflin and Mr. Truitt, of the staff of Virginia Military Institute, were also present.

President Bird called the meeting to order at 9:45 A.M. The first order of business concerned the Virginia Academy Conference. It was proposed that the reading of committee reports be eliminated in order to save time, and be limited to five hundred words for printing in the Proceedings.

Marcellus Stow suggested that the reports be mimeographed in advance and available for each member desiring information prior to printing of the Proceedings. The report of the Business Committee, that of the Research Committee, and that of the Secretary would be read before the Conference; and copies of the reports should be sent to the Council in advance so that any controversial matters which might arise could be discussed before the meeting. It was properly moved and seconded that the Secretary instruct each person authorized to make a report to submit such committee report to the Secretary at least a week before the annual committee meeting, and that copies of such reports be mimeographed on letter-size paper and made available for all members who registered at the meeting.

It was further moved, seconded, and passed, that such reports, or summaries of four hundred words or less be sent to the Editor-in-Chief of the Virginia Journal of Science for publication, unless a more complete report for publication is required by the Council.

\$2,500 of the general funds was authorized to be invested in recognized securities, the income of which is to be used for general expenses of the Academy.

Marcellus Stow reported on the status of the proposed Dismal Swamp Project for the Long Range Planning Committee. He stated that the lowering of the water table in the swamp, and program of Reforestation by the Camp Manufacturing Company, would gradually change the swamp from its present natural status, and consequently the proposed study would not have the interest that was contemplated. He suggested that a further study be made of the situation, and a further report made at the Annual Meeting.

President Bird read a letter from Henry Leidheiser of the Virginia Institute of Scientific Research, that suggested a "New Activities Committee".

It was suggested that the President answer Mr. Leidheiser's letter, and appoint him on the Long-Range Planning Committee.

President Bird told the Council about the William Ralston Memorial Award that had been established to encourage good expression in scientific writing. It was suggested that, subject to the approval of the Executive Committee of the Virginia Section, the Award might be handled advantageously through the Academy. After considerable discussion, the suggestion was approved in principle.

It was moved, seconded and passed, that, in addition to the Secretary, President-Elect Allan T. Gwathmey, be appointed as a delegate to the Academy Conference of the AAAS at the St. Louis meeting.

After considerable discussion it was moved and passed that the customary Academy dinner, both Junior and Senior, be eliminated.

The Council recommended that the President contact college and university authorities regarding the possibility of increasing the value of scholarships offered to State Science Talent Search winners, and also the possibility of continuing such scholarships for four years.

It was moved, seconded, and passed, that the fiscal year of the Academy be changed to correspond with the calendar year. This action is subject to the approval of the Academy at the Annual meeting. It was suggested that the Secretary and Editor-in-Chief work out details and conflicts which might arise due to such change.

Since such action would require change in the Constitution Article II, Section 2, which now reads. "The fiscal year of this organization shall be from April 1 to March 31." This to be changed to read: "The fiscal year of this organization shall be from January 1 to December 31." Publication of this notice in the Journal shall constitute the proper notice.

It was moved, seconded and passed, that the present fee of \$10.00 for the Collegiate Chapter be changed to \$3.00 per year, for which such Chapters will receive one subscription to the Virginia Journal of Science instead of two.

Dr. Boyd Harshbarger discussed bids offered for publication of the Journal for the coming year, and on his recommendation it was moved, seconded, and passed, that the bids of the Pearisburg Virginian, by Malcolm Donald Coe, be accepted for two years. There being no further business the Council adjourned at 12:20 P.M.

Following lunch the President's Advisory Committee convened in the library at 2:00 P.M. Most of the members of the Local Committee on Arrangements were present and problems relative to the Annual Committee at V.M.I. were discussed for the benefit of the committee.

Present were: Major Nichols, Colonel Anderson, Messrs. Dobson, Jarman, Webb, of V.M.I.; Stow, Black, Husted, Brumfield, Jopson, Myster, Flory, Harshbarger, Obenshain, Patterson, Horsley, Weaver, Truitt, Gwathmey, Negus, Carroll, Foster, Smith, Bird, Colonel Heflin, Jeffrey, Mrs. Remsberg, and Mrs. Heatwole. Obenshain made a report to the group on the new set-up of the Speakers Bureau. Colonel Carroll, of V.M.I., reported on the activities of Collegiate members.

Mrs. Heatwole made a report on the plans for the program of the Junior Academy meeting and publicity that was being planned.

Colonel Anderson expressed the pleasure of V.M.I. in entertaining the Academy at its Annual meeting.

The meeting adjourned at 5 P.M.

FOLEY F. SMITH, *Secretary*

MINUTES OF THE JUNIOR ACADEMY OF SCIENCE BUSINESS MEETING

The eleventh annual meeting of the Virginia Junior Academy of Science was held on Thursday, May 7th, in the auditorium of Prescott Library on the campus of the Virginia Military Institute. The meeting was called to order by the president, Claude Barfield. The group was welcomed by the president of the Senior Academy, Mr. Lloyd C. Bird. Mr. Bird stated in his welcome, as a challenge to the Junior Academy members, that all new things come by hard work and research.

Next, the president introduced the incumbent officers of the Junior Academy, Ervin Tyler, President-elect, and Charles Chamberlayne, Secretary. He also introduced the members of the Junior Academy Committee.

Following the introductions, the secretary read the minutes of the 1952 meeting which was held at the Chamberlin Hotel on May 15th. He reported that 14 schools were represented at this meeting. The minutes were approved with no corrections and the secretary then went on to read reports of the business transacted at the three meetings of the Junior Academy Committee.

A roll call of affiliated clubs showed the following schools represented:

Andrew Lewis H. S.	Madison Heights H. S.
Radford H. S.	Buckingham Central H. S.
Norview H. S.	Martinsville H. S.
Newport News H. S.	Woodrow Wilson H. S.
Wilson Memorial H. S.	Thomas Jefferson H. S.
Lexington H. S.	Booker T. Washington H. S.
Lane H. S.	(Norfolk)

Many other schools were represented by individual affiliates.

The next item on the agenda was the reports of the various committees. Dr. Humphries recognized the members of her committee who made the selection for the E. C. L. Miller Award. Dr. Gwathmey reported that his committee had succeeded in having the Teacher-Sponsor Scholarship raised from one to two hundred dollars. Dr. Reynolds gave the list of judges who judged the individual and club exhibits. They were Dr. Marcellus Stow, Geology; Dr. William Hinton, Psychology; Dr. Lilliam Thompson, Biology; Dr. E. D. Miller, Biology; Dr. Fred L. Brown, Physics; and Dr. T. Nelson Baker, Chemistry. Dr. Reynolds stated that, with one or two exceptions, every judge had interviewed each exhibitor. Mrs. Heatwole gave a report on the work done by the Junior Academy Committee. She stated that there were 65 clubs this year, 54 of thoes being new affiliations. She commented on the JUNIOR SCIENCE BULLETIN which was published this year, and gave special thanks to Miss Susie V. Floyd and the Newport News High School print shop for making its publication possible.

The report of the nominating committee was then given by Miss Martha Robinson of Newport News High School. She introduced the candidates and briefly stated their qualifications. They were Jackie Chaffin, Martinsville, candidate for president; Eleanor O'Meara, Charlottesville, and Alex Gardner, Salem, candidates for secretary. Following the report the floor was opened for nominations. A motion was made, seconded, and carried to cast a unanimous ballot for Jackie Chaffin for president. Following this Eleanor O'Meara was elected secretary.

Following the recognition of the newly elected officers, the president installed his successor, Ervin Tyler. The meeting was adjourned by Mr. Tyler.

CHARLES H. CHAMBERLAYNE

MINUTES OF THE SECTION OF AGRICULTURAL SCIENCE [1]

T. J. NUGENT, *Chairman*

H. MARSHALL CLARK, *Vice-Chairman*

RODNEY C. BERR, *Secretary*

WESLEY P. JUDKINS, *Section Editor (1956)*

FRIDAY, MAY 8, 1953 — 9:00 A.M. — ROOM 234, MALLORY HALL

1. INSECTICIDES: RESEARCH

D. E. Greenwood; *Virginia Truck Experiment Station, Norfolk.*

Insecticidal research begins even before the first few grams of an agricultural chemical are made, and through the combined efforts of a research team, the product is evaluated to a point of successful production. When final application is made for label approval, a sound research and developmental program will have supplied the necessary facts relating to its effectiveness against insects, its safety to humans both from the standpoint of hazards in handling and possible dangers from residues remaining on treated produce, and above all, for the development of suitable analytical techniques for measuring the factors mentioned. Experiment Station personnel generally enters the picture after toxicology, analytical procedures, and other necessary preliminary phases have been started, and their primary function is to adapt promising compounds to practical agricultural use. The cost of developing an agricultural chemical is great but agriculture needs these pest control materials and industry is willing and able to provide them.

2. INSECTICIDES-REGULATORY LAWS.

J. Claggett Jones; *Virginia Department of Agriculture, Richmond.*

Since July 1, 1948, the Virginia Insecticide, Fungicide, and Rodenticide Law of 1948 has been in effect, superseding the old Insecticide Law of 1922. In place of its rather long and unwieldy legal name, it is commonly referred to as the Virginia Insecticide Law, the Virginia Pesticide Law, or the Virginia Economic Poison Law. Under the Law's definition an economic poison is any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any insects, rodents, fungi, bacteria, weeds, or other forms of plant or animal life or viruses (except viruses on or in living man or other animals) which the Virginia Commissioner of Agriculture shall declare to be a pest.

The purpose of the Law is to protect the health, welfare, and pocket-book of Virginia residents from intentional wrongdoers, from careless or ignorant violators, and from potential causes of accidents.

To carry out the intent and purpose of the Law, three essential procedures are provided under the Law. These are registration, inspection and analysis.

With over 2500 products registered, one can readily see that the enforcement of the Law is not only a large job, but an important one.

3. CONTROL OF MITES IN STRAWBERRIES IN VIRGINIA.

R. N. Hofmaster and D. E. Greenwood; *Virginia Truck Experiment Station, Norfolk.*

A number of acaracides were tested during 1951-52 at the Virginia Truck Experiment Station in an attempt to develop improved measures for mite control on strawberries. Particular emphasis was placed on cool weather treatments since damaging mite infestations often occur in late winter or early spring. Treatments with Systox, a systemic insecticide, approximately one month before harvest with 1 pint, or six weeks before harvest with 1.5 pints, of 48.1% emulsion per acre appear sufficient to insure good mite control through the harvest period. In 1951 one pint of Systox per acre applied to ripening fruit showed a residue (bioassay method) of only 0.1 ppm when harvested eight days later. None of the Systox treatments in 1952 had measurable residues as determined by the cholinesterase method. Although less effective than Systox, 10% Ovotran and 3% commercially prepared Aramite gave good control in early spring treatments and were superior to all other compounds. Combinations of parathion with sulfur and Ovotran produced significantly better results than any of these materials alone. The organic phosphorous compounds were characterized by a high initial kill and limited residual action.

4. EFFECT OF VARIETY ON THE ASCORBIC ACID AND CAROTENE CONTENTS AND ON THE YIELD OF SWEET POTATOES.

James F. Eheart, P. H. Massey, Jr., and R. W. Young; *Virginia Agricultural Experiment Station, Blacksburg.*

A moist type sweet potato variety study consisting of 8 varieties and 3 field replications was made at the Eastern Virginia Research Station, Warsaw, Virginia. Variations among varieties of the ascorbic acid, carotene, and moisture contents, No. 1 and total yields, and color and taste preferences were studied. Final ranking of the varieties by considering the above constituents showed the following choices: 1st, B-5999, Allgold, B-5941, and Goldrush; 2nd, L-240; 3rd, Ga. Bunch P. R. and Heartogold; and 4th, Unit I Porto Rico. This Southern Cooperative Group experiment was cooperatively conducted at the Georgia, Louisiana, Mississippi, North Carolina, Oklahoma, and Virginia Experiment Stations and the USDA Bureau of Plant Industry, Beltsville, Maryland.

5. THE EFFECT OF LIGHT, SOIL, pH, AND TRACE ELEMENTS ON THE ASCORBIC ACID, CAROTENE, THIAMINE AND RIBOFLAVIN CONTENTS OF TURNIP GREENS.

P. H. Massey, Jr., James F. Eheart and R. W. Young; *Virginia Agricultural Experiment Station, Blacksburg.*

An experiment was conducted in the fall of 1952, at the Virginia Agricultural Experiment Station, to study the effect of soil pH, light intensity and trace elements (none, applied to foliage, applied to soil), on the moisture, ascorbic acid, carotene, thiamine, and riboflavin contents of turnip greens. A split factorial design with six replications was used for this test. Three trace element treatments were applied: (1) none, (2) applied to foliage, and (3) applied to soil.

Under the conditions of this experiment, none of the factors studied had a significant effect on the ascorbic acid content of the greens. The significant results of the factors studied on the other constituents, on the dry basis, may be summarized as follows:

1. Shading two weeks prior to harvest resulted in an increase in carotene and a decrease in the riboflavin content.
2. Soil application of trace elements resulted in an increase in thiamine.
3. The no shade - no lime treatment gave an increase in the thiamine content.
4. The treatment combination of soil application of trace elements and no shade resulted in the highest riboflavin content.

6. TRACE ELEMENTS OF SOME VIRGINIA PASTURE PLANTS.

Nelson O. Price and W. N. Linkous; *Virginia Agricultural Experiment Station, Blacksburg.*

(No abstract available)

7. A SUGGESTED ROLE FOR AGRICULTURAL SCIENTISTS IN MINERAL PROSPECTING.

Richard V. Dietrich; *Virginia Polytechnic Institute, Blacksburg.*

In recent years there has been a drastic depletion of known mineral resources. To assure continued industrial development, either substitutes for or new supplies of these minerals must be found.

There are undoubtedly mineral deposits that have thus far escaped discovery because they are covered with soil. Soil analyses and plant analyses involving determinations of such trace elements as Co, Cu, Zn, Mo, B, and W commonly are made by agricultural scientists in attempts to determine the nutrient effects of very small amounts of certain elements. Because concentrations of these elements in soil and plants may reflect the chemical characteristics of the underlying bedrock, these analy-

ses may serve as a basis for reconnaissance geochemical and biogeochemical maps.

A plea is made to the agricultural scientists that make such analyses to make their results readily available to geologists.

8. THE RELATIONSHIP BETWEEN SIZE AND EFFICIENCY OF FEED UTILIZATION IN BEEF CATTLE.

J. E. Grizzle and C. M. Kincaid; *Virginia Agricultural Experiment Station, Blacksburg.*

A study on the relationship between weight and daily feed consumption from data collected on bulls and steers individually fed over a five-year period showed that the linear regression of daily feed consumption on weight explained a highly significant amount of the variation in feed consumption. After adjustment for linear regression, the data showed highly significant differences among periods and animals within groups. Group differences were highly significant in the 1950-51 and 1951-52 bulls and steers, and the group-period interactions were significant in all animals fed except the 1947-48 bulls and 1951-52 steers.

It appears from the data secured in this experiment that rate of gain is a better measure of efficiency than the ratio of gain to feed consumption unless adjustment is made for differences in weight or constant end weights are used. Pounds of feed per pound of gain as a measure of efficiency in feeding trials may be misleading. In general, the younger and therefore smaller animals tended to be more efficient because they ate less feed than larger ones. In these trials, rate of gain tended to be more or less constant for the period from weaning to fifteen months of age.

9. SILAGE STUDIES.

Paul M. Reaves and R. Emory Brubaker; *Virginia Polytechnic Institute, Blacksburg.*

I. Sulfur Dioxide as a Preservative.—Sulfur dioxide was added as a preservative to alfalfa silage. An average of 3.58 pounds of sulfur dioxide per ton of chopped material was used. The silage was well preserved and retained much of its green color. The silage did not have the normal odor of silage acids (lactic and acetic). Apparently the formation of sulfuric acid from the sulfur dioxide inhibited the production of the organic acids in the normal amounts. There was no evidence of butyric acid development. The alfalfa-sulfur dioxide silage was not so palatable as corn silage; however, when the cows became accustomed to it they ate it well and in large quantities.

II. The Carry Over of Weed Flavors.—A silo was filled with a mixture of approximately 55 percent clover and wheat stubble and 45 percent ragweed. Molasses was used as a preservative. The silage was fed

to milking cows 15 minutes to 1½ hours before milking time. The silage had a normal silage odor with no ragweed odor present. It was not so palatable as corn silage. Samples of milk were taken at time of delivery at the milk plant and showed no ragweed flavor.

10. THE EVALUATION OF STRESS IN DAIRY CATTLE.

G. C. Graf; *Virginia Agricultural Experiment Station, Blacksburg.*

Various stress conditions to which dairy cattle were subjected were evaluated by means of changes in respiration rates, heart rates, rectal temperatures, plasma lactic acid and creatinine levels, and electrocardiograms. The stress conditions evaluated were low ambient temperatures, exercise, dehorning, parturition, adrenaline injections, intermittent electrical shock, milking, and rumination. The changes in the plasma lactic acid level were found to be the most sensitive in most cases. Changes in heart rate and respiration rate were also valuable. Electrocardiograms gave results in the adrenaline injection series which portrayed the cardiac changes very vividly. Changes in the rectal temperatures and plasma creatinine level were found to be of little value in the evaluation of stress under the conditions noted.

11. A STUDY OF NEW MODIFIED BABCOCK TESTS.

C. C. Flora and G. E. Fisher; *Virginia Polytechnic Institute, Blacksburg.*

The first practical method for testing the butterfat content in milk was the Babcock test which was devised by Dr. S. M. Babcock of the University of Wisconsin in 1890. This test was adapted by the dairy industry because of its simplicity, cheapness, and accuracy.

A new detergent test was developed by Dr. Schain of the Veterans Administration, Staten Island, New York, in 1949. The Bureau of Dairy Industry has made a very thorough study of the detergent test and they have developed a test of their own using one detergent plus a water softener.

With fresh milk the results of the Schain test in our laboratory checked very close to the Babcock method when a monograph was used. Similar results were obtained with the BDI test without any corrections. The Schain test did not prove very satisfactory for testing cream.

12. INFORMATION WHICH CAN BE OBTAINED AT THE BEGINNING OF LONG-TIME CROPPING AND FERTILIZER EXPERIMENTS.

Russell K. Stivers; *Virginia Polytechnic Institute, Blacksburg.*

The hypothesis is advanced that the knowledge of soil differences occurring within replications or blocks at the beginning of a long-time cropping or fertilizer experiment will help greatly in the interpretation of

results. Examples of differences in crop response on plots treated alike are given. These differences in crop response are attributed to differences in soil fertility, differences in the incidence of soil borne plant diseases or parasites, and in soil physical differences. These examples are used to illustrate how the knowledge of soil differences occurring within a block may be used to evaluate the results from a long-time cropping or fertilizer experiment or to revise it.

13. A PICTURESQUE TRIP THROUGH THE DISMAL SWAMP OF VIRGINIA.

Elvin F. Henry; *Virginia Polytechnic Institute, Blacksburg.*

(A pictorial presentation, no abstract available.)

BUSINESS MEETING

At the close of the speaking program the annual business meeting was held. The following men were elected to hold office for the 1953-54 period:

Chairman — H. Marshall Clark, Tidewater Field Station, Virginia Agricultural Experiment Station, Holland.

Vice-chairman — Rodney C. Berry, Director and State Chemist, Department of Agriculture and Immigration, Richmond.

Secretary — R. W. Engel, Virginia Polytechnic Institute, Blacksburg.

Section Editor — Wesley P. Judkins, Virginia Polytechnic Institute, Blacksburg.

MINUTES OF THE SECTION OF ASTRONOMY, MATHEMATICS, AND PHYSICS [2]

S. M. HEFLIN, *Chairman*

L. W. WEBB, JR., *Secretary*

I. G. FOSTER, *Section Editor (1956)*

FRIDAY, MAY 8 — 10:00 A.M. — ROOM 111, MALLORY HALL

1. A New Theory of Convergence.

E. J. McShane; *University of Virginia.*

Every idea of limit contains a central part which, roughly stated, asserts that we can make $f(x)$ stay in any one Y of a family \mathcal{Y} of sets (for example, the family of all circles centered on a point p) by restricting x to lie in some set X of a family \mathcal{X} . A certain simple restriction on the families \mathcal{X} is needed if we wish to be able to prove that the limit of a sum is the sum of the limits. No further restrictions are needed. The resulting definition of limits is at least as general and convenient as any existing general theory, and unifies all limit-concepts into a single concept of rather simple type.

2. On the Embedding of a Sequence of Closed Sets in a Sequence of Arcs.

B. J. Ball; *University of Virginia.*

The sequence α of point sets will be said to be embedded in the sequence β of arcs provided that each term of α is a subset of some term of β and each term of β contains some term of α . The problem considered is that of obtaining conditions on a sequence α of sets in order that it be embedded in a sequence of arcs satisfying previously specified conditions. The space considered is the plane and it is assumed that each term of α is closed and totally disconnected and that the sum of the terms of α is bounded. Conditions are obtained which are sufficient, or in some cases necessary and sufficient, for α to be embedded in (a) a convergent sequence of arcs, (b) a sequence of mutually exclusive arcs, (c) a convergent sequence of mutually exclusive arcs, (d) an equicontinuous sequence of arcs, and (e) a convergent, equicontinuous sequence of mutually exclusive arcs.

3. Inelastic Scattering of D-D Neutrons.¹

R. E. Garrett, F. L. Hereford, and B. W. Sloope; *University of Virginia.*

The inelastic scattering of D-D neutrons by various elements has been studied through observation of the gamma radiation emitted by the de-

¹ Supported by U. S. Navy Contract Nord—7873.

exciting residual nuclei. Gamma rays were detected in a 1" diam. by 1" thick NaI(Tl) scintillation crystal in coincidence with detection of scattered neutrons in a 1" cube of stilbene. Differential analysis of the NaI pulse height spectrum was performed for all such coincident events, yielding the energy spectrum of the gamma radiation associated with scattered neutrons. Coincidence rates were normalized relative to a BF³ proportional counter which detected neutron intensity in the vicinity of the target. The gamma-neutron coincidence technique eliminated background gamma radiation. Four inches of paraffin shielded the stilbene crystal from both the deuterium target and NaI crystal. The following levels (given in Mev) have been observed in the indicated target nuclei: Mg: 1.40; Al: 0.84, 1.02, 2.2; Fe: 0.82, 1.45, 2.2; Cu: 1.1, 1.52, 2.14. Most of the Al, and Mg levels are in agreement with previously reported data obtained by similar methods.²

4. General Equation for Conics and Pseudoconics.

Richard E. Herron and D. S. Davis; *Virginia Polytechnic Institute.*

A geometrical construction that employs the convergence point (f, g) and the circle

$$(R \cos \theta - h)^2 + (R \sin \theta - k)^2 = a^2$$

of radius a and center (h, k) results in the general equation

$$r = \frac{g R}{g - f \tan \theta + R \sin \theta}$$

which holds for all conic sections (Davis, D. S., Va. J. Sci., 1 (1) 60 (1950)) and for the pseudoconics: Amelia, Bocanegra, Cavaradossi, and La Tosca (Davis, D. S., Va. J. Sci., 2 (3) 203-9 (1951)).

5. Pictures in Polars.

J. L. Troutman, J. M. Reynolds, and D. S. Davis; *Virginia Polytechnic Institute.*

Solely in the spirit of recreation, polar equations are offered for the outlines of apples, badges, butterflies, lemons, "schmoos," socks, and other familiar objects.

6. Lens Aberrations — Demonstration and Experiment.

I. G. Foster, *Virginia Military Institute.*

Simple apparatus for illustrating the five geometric lens aberrations is shown. All aberrations are made visible by projection on a screen. They may thus be seen by a large group. This apparatus can also be adapted for use as a semi-quantitative experiment for the laboratory.

² Robert V. Day, Phys. Rev. 89, 908 (1953).

7. An Investigation of the Linear Relationship Between Resistance and Fourth-Root of Power Input of a Tungsten Lamp.

M. E. Cruser, Jr. and E. C. Stevenson; *University of Virginia*.

It is customary in elementary physics to determine and plot the resistance of tungsten and carbon filament lamps as functions of power input. We have found that when an evacuated tungsten lamp is operated on direct current, its resistance versus the fourth root of the power input is a straight line for a range of power from five per cent to three hundred per cent of rated value. It might be surmised from this that over the range of temperature change involved: (1) the radiation is proportional to the fourth power of the absolute temperature and conduction losses are insignificant; (2) the resistance of the filament is a linear function of its temperature; (3) the radiation emissivity is constant. When the temperature coefficient and emissivity are calculated from these and other data such as filament temperature and surface area, there is no satisfactory agreement with tabulated values; in fact, the latter show that both coefficients increase with temperature. It is a remarkable coincidence that the ratio of the effective temperature coefficient to the fourth root of the emissivity is a constant over such a wide range.

The above linear relation does not hold for gas filled tungsten or carbon filament lamps.

8. The Energy Loss of Mu-Mesons and Electrons in Sodium Iodide.

G. M. Snead and S. J. Stratis; *University of Virginia*.

Scintillation methods have been used to investigate the energy loss of electrons and cosmic ray mu-mesons in NaI(Tl) crystals. The thickness of the crystals were much less than the ranges of the particles so as to give a distribution of energy losses. The most probable energy losses and the energy loss distributions were compared with those calculated from Landau's³ theory, with and without the density correction proposed by Halpern and Hall.⁴ The mu-meson results agree within experimental error with the density corrected theory. The energy loss distributions for the electrons are much wider, and the most probable energy losses are 15% greater, than those predicted by theory. The latter is believed due to multiple scattering. The relative rise in energy loss with increasing electron energy is in good agreement with the density corrected theory.

9. Teaching Physics as a Profession.

S. M. Heflin; *Virginia Military Institute*.

The demand for good teachers in physics is great and the vocation is a laudable one. The influence of the teacher is immeasurable and

³ L. Landau, *J. Physics, USSR*, 8, 4 (1944).

⁴ O. Halpern and H. Hall, *Phys. Rev.* 57, 459 (1940).
Phys. Rev. 73, 477 (1948).

the rewards for imparting truth is a great satisfaction. The financial rewards have not been too high, but they are improving and we should continue our efforts along this line. We are proud of our profession and we should lend our influence to induce men of high character, keen minds, and patience to enter this field of endeavor.

10. Tensile Strength and Adhesion of Thin Films of Silver.⁵

Harold S. Morton, Jr.; ⁶ *University of Virginia.*

Work has continued at the University of Virginia on determination of the tensile strength and adhesion of thin metallic films.⁷ The studies involve subjecting the films to high centrifugal fields. Thin silver films have been electrodeposited without preliminary "striking" on small cylindrical hardened steel rotors. The rotors have then been magnetically suspended and spun in a high vacuum, and the rotational speeds required to throw off the films have been measured for various film thicknesses. In agreement with previous results and in general agreement with theory, the tensile strength has been found to show a very abrupt increase when the film thickness is reduced to about 2.5×10^{-5} in.. In addition, the adhesion shows an increase at roughly 1.6×10^{-5} in.. Prolonged annealing at 300° C increases the adhesion. Alternate rapid cooling and heating between -70° C and 90° C greatly reduces the adhesion, and facilitates tensile strength measurements at small film thicknesses. In general, adhesion has been found to be more sensitive to variations in electrodeposition procedure than has tensile strength.

11. The Equilibrium Ultracentrifuge.⁸

A. Robeson, N. Snidow, and J. W. Beams; *University of Virginia.*

A 7.5-inch diameter ultracentrifuge rotor is magnetically suspended in a vacuum chamber (pressure 10^{-6} mm. Hg) and driven to operating speed by an air turbine below the chamber. The turbine is connected to the rotor with a thin flexible shaft which passes through a vacuum tight gland and which is disengaged from the rotor at operating speed. The rotor coasts freely during the observations and loses less than 1 rps per day. The concentration across the ultracentrifuge cell is determined by the refractive index measured by an interferometer arrangement which employs both white light and monochromatic fringes. A shift of 0.05 fringe is measurable. The rotor speed may be measured to one part in 10^6 and the rotor temperature maintained constant to 0.01° C. The apparatus is especially adaptable to molecular weight determinations in the range from 300 to 10,000.

⁵ Supported by Navy Bureau of Ordnance.

⁶ National Science Foundation Fellow.

⁷ Beams, Walker and Morton, Phys. Rev. 87, 524 (1952).

⁸ Supported by Navy Bureau of Ordnance.

12. Magnetic Balance.

Walter E. Lotz, Jr.; *University of Virginia.*

Beams⁹ observed that when a small steel sphere was suspended in the magnetic field of a solenoid, the current in the solenoid being controlled by light reflected from the sphere and the space surrounding the sphere was evacuated, the sphere dropped a measurable distance. Using a microscope to observe the position of a $1/64''$ sphere, he was able to detect changes of mass of 10^{-8} to 10^{-9} gram.

Theoretical considerations indicate that mass changes as small as 10^{-9} grams may be observed if the servo-mechanism holding the sphere in suspension is sufficiently stable. The mass change may be detected by observing changes in the solenoid current, changes in the position of the supported sphere, or changes in other parameters of the support control system. The theory predicts that in the ultimate, the magnetic balance is more sensitive than the chemical balance to small differences in mass.

A balance has been constructed incorporating modulated position error signals and electrical recording of mass change deflections. It is expected that mass changes as small as 10^{-9} grams will be observable.

13. Proton Resonance Absorption Fluxmeter.

R. T. Wagner; *University of Virginia.*

A proton resonance fluxmeter was built with the object of accurately measuring an approximately 600 gauss field strength produced by an air core solenoid used for magnetic suspension of steel rotors. Hahn and Knoebel's¹⁰ circuit was modified to permit resonance detection using 0.1 cc. proton samples. Weak fields and reduced proton sample volume combine to place a lower limit of 400 gauss measuring ability of this fluxmeter. Other nuclear resonance absorption methods were tried¹¹ which gave similar results. The effect of inhomogeneity of the solenoidal field and other factors which combine to place limits on the use of proton resonance fluxmeters will be discussed together with oscillograms of observed resonances. Schematic diagrams of circuits used to detect resonance will be shown.

14. Gyromagnetic Ratios.

Glen S. Waterman; *University of Virginia.*

A new and direct method of measuring the gyromagnetic ratios of ferromagnetic substances, with the possibility of high ultimate precision, is currently under development at the University of Virginia. A minute sphere or cylinder of the sample material is supported, frictionlessly in vacuo, symmetrically between two identical, vertical axes, air-core sole-

⁹ J. W. Beams, Rev. Sci. Inst. 21: 182, (1950).

¹⁰ Hahn and Knoebel, RSI, 22, 194 (1951).

¹¹ Pound and Knight, RSI, 21, 219 (1950).

noids. The field strength impressed on the sample induces a dipole magnetic moment proportional to the sum of the coil currents. The supporting force is equal to the product of the magnetic moment with the vertical component of the gradient of the impressed field, which is proportional to the difference of the coil currents. Since the gradient H' and the field H are independently controlled, the sample may be held in suspension for a large change in impressed field, and thus for a large change in the magnetic moment of the sample. The gyromagnetic ratio causes a rotation of the sample, which can be observed, and together with observations of the coil currents and a knowledge of the coil constants and measurements of the samples, simple algebra permits a determination of the gyromagnetic ratios.

15. Correction of Watches by Induced Oscillations.

L. G. Hoxton; *University of Virginia.*

It is known that watches, hung on pins, may change their rates while executing pendular vibrations. No systematic treatment, if it exists, has yet been found by the author.

An experimental study with bifilar suspensions is here reported. The problem is considered in terms of: (1) a vibrating system with two degrees of freedom and (2) forced oscillations.

The vibrating elements considered are (a) the balance wheel and (b) the rest of the watch with a suspending cradle, called the "frame". The balance "drives" the frame, for the energy derived from the mainspring is delivered only slightly to the frame except through the balance.

From (1) the watch will lose or gain according as the balance and frame are together or opposite in phase. Further, in virtue of (2), these phase relations can be sufficiently predetermined through control of the free period of the frame.

Application is made to pins, illustrated here by an example. A Hamilton 992B, hung on a .25 mm. pin, lost; on a 2.4 mm. pin, gained; the rates being 8 to 15 sec./hr. On a 3.0 mm. pin it would gain or lose, the uncertainty residing in the initial conditions which are unknown close to a state of resonance.

16. Magnetic Suspension Circuits.

Joseph Swingle; *University of Virginia.*

17. A Double Ultracentrifuge Cell.

J. W. Beams and H. M. Dixon; *University of Virginia.*

The analytical ultracentrifuge may be used to determine the concentrations of substances in solution as well as their molecular weights. A troublesome source of uncertainty in concentration measurements is the distortion of the centrifuge cell by the large stresses produced in a high speed rotor. The effect of distortion on concentration determinations may

be eliminated to a first approximation by a double cell consisting of two sector shaped wells side by side having the same quartz windows and cell housing. If one sector is filled with a solution of the molecular species whose concentrations are to be determined and the other sector is filled with the solvent, a conventional Thovert-Philpot-Svennson cylindrical lens and slit optical system will superpose a baseline on the same photographic plate which shows the index of refraction changes produced by the sedimenting substances.

18. Ferromagnetic Deflection of High Energy Electrons.¹²

Stephan Berko and Frank L. Hereford; *University of Virginia.*

Deflection experiments in magnetized iron show the macroscopic B to be the effective magnetic vector acting on mu-mesons. An experiment by Alvarez¹³ in 1934 indicates, however, negative results for Radium C β -rays. In a recent paper¹⁴ Wannier showed that the magnetic deflection is separable from multiple scattering only at higher electron energies. The experiment to be described uses magnetically analysed 7.4 Mev electrons from the $B^{11}(d,p)B^{12}$ (β -)C¹² reaction. The collimated electron beam is scattered by an iron (Vanadium Permendur) sheet and is detected by a movable counter telescope. Multiple scattering curves are taken with the magnetic field in the iron in both directions. From the shift of the scattering distributions, the effective magnetic field is computed and found to be the macroscopic flux intensity B, showing therefore no short range electron-electron forces at these energies.¹⁴ Saturation effects will be discussed.

19. The Polarization of Annihilation Quanta and the Einstein, Podolsky, Rosen Experiment.

F. L. Hereford and S. Berko; *University of Virginia.*

The argument presented by Einstein, Podolsky, and Rosen¹⁵ (EPR) purporting to demonstrate the incompleteness of the quantum mechanical description of the physical world has been refuted on theoretical grounds by several authors.¹⁶ To demonstrate their contention EPR introduce a hypothetical experiment. Recent measurements^{17, 18} of the correlation between polarization states of positronium annihilation quanta can be shown to be analogous to the EPR experiment. In the case of the annihilation quanta their argument leads to the conclusion that quantities which represent both quantum and classical descriptions of the polarization of light do not represent a complete description (one which contains

¹² Supported by Office of Ordnance Research, U. S. Army.

¹³ L. Alvarez, *Phys. Rev.* 75, 225 (1934).

¹⁴ G. Wannier, *Phys. Rev.* 72, 304 (1947).

¹⁵ A. Einstein, B. Podolsky and N. Rosen, *Phys. Rev.* 47, 777 (1935).

¹⁶ See D. Bohm "Quantum Theory" (Prentice-Hall Inc., New York, 1951) p. 611 for a complete discussion.

¹⁷ C. S. Wu and I. Shaknov, *Phys. Rev.* 77, 136 (1950).

¹⁸ F. L. Herford, *Phys. Rev.* 81, 482, (1951).

a mathematical counterpart for each "element of reality" as defined by EPR). The quantum mechanical formalism in which the state of a system is not precisely defined but can only be realized in interaction with a measuring device yields a satisfactory description which as shown elsewhere¹⁶ is complete.

20. Some Proposed Experiments with Liquid Helium II.

J. W. Beams; *University of Virginia.*

Liquid Helium II below 2.19 K forms a thin film which creeps over surfaces and against gravity for heights of at least several meters. Although this film has been widely investigated, its true nature is not understood. In this paper it is proposed to partially fill a hollow, magnetically suspended steel rotor (provided with the proper baffles to prevent stirring both of liquid and vapor) with liquid helium II in such a way that the helium II films will be forced to creep from the periphery toward the axis in order to get out of the rotor. The rotor will then be spun to the speed just necessary to prevent the film from reaching a small circular opening in the rotor concentric with the axis of rotation. This will then give a measure of the force necessary to stop the creeping film. If the film is successfully stopped by the centrifugal field, then by pumping the helium vapor out of the axis of the spinning rotor very rapidly, the temperature of the rotor should be quickly reduced to a point where the vapor pressure of helium is negligibly small, possibly below 0.5° K. Apparatus for testing this proposal is under construction.

21. A Simple Method for the Measurement of the Surface Temperature of Rapidly Rotating Bodies.

A. R. Kuhlthau and E. M. Foley; *University of Virginia.*

A simple method for the measurement of the surface temperature of objects with which one is unable to make contact has been developed. The technique involved the measurement of the infrared radiation from the body and the comparison of this radiation with that received from a similar body at known temperature. A lead sulfide cell is used as the detector and the radiation beam is modulated mechanically at a frequency of 10 c.p.s. The ten cycle output of the cell is then amplified by a tuned amplifier whose output may be calibrated to give the desired temperature directly. Calibration methods are discussed. Temperature differences of 0.25° C are readily measurable in the vicinity of room temperature or lower and at higher temperatures, this sensitivity increases to about 0.1° C. With appropriate modifications of the apparatus it is possible to increase this sensitivity at all temperatures.

22. Astrometric Orbit of Gamma Geminorum.

Harold L. Alden and V. Osvalds; *University of Virginia.*

The variable radial velocity of Gamma Geminorum was discovered by Burns at the Lick Observatory in 1905. In 1912 Harper at the Dominion Observatory derived an orbit with a period of six years and a semi-major axis of the order of one astronomical unit. Measures of radial velocity made subsequently fail to fit this credit. However, because of its possible angular dimensions, it seemed to warrant astrometric study.

Forty-eight plates were taken with the McCormick telescope between March 1946 and March 1952. These have been measured by Osvalds. After eliminating the parallax and proper motion, the residuals show no significant correlation with the six year period in either coordinate. A period of 300 days would reduce the residuals slightly. This period seems to be ruled out, however, by the radial velocity observations.

23. Population Groups Among Stars of Spectral Type G.

A. N. Vyssotsky; *University of Virginia.*

Two groups of G dwarfs have been distinguished spectroscopically both at the Yerkes Observatory among bright stars and at the McCormick Observatory among faint stars. In one group the solar motion and the dispersion in the peculiar motions are only two-thirds as large as in the other. A similar spectroscopic differentiation among K giants indicates that the first group is more closely connected with the spiral structure of the galaxy than is the second.

24. Effect of Contamination on Transmission and Reflection of Light by Thin Metal Films.

H. Y. Loh and Peter Cheo; *Virginia Polytechnic Institute.*

Silver and copper thin films of controlled thickness have been made by evaporation and their transmission and reflection of monochromatic light studied in a vacuum. It was noted that at low pressure they are very sensitive to grease vapor. The effect on transmission and reflection is tremendous. It may cause a change as much as several hundred percent of their original values in some cases depending upon the thickness of the film. The cause of the effect is discussed.

25. A Report on the Washington State Bolide of May 10-11, 1952.

Charles P. Olivier; *Flower Observatory, University of Pennsylvania.*

On the night of 1952 May 10-11 at 12:27 A.M., P.S.T., a very brilliant bolide or detonating fireball passed over the southwestern part of the state of Washington and ended to the northeast of Seattle. It was so brilliant and the sound effects so intense that great alarm was caused locally, some thinking that a bomb had been dropped. Data were

gathered for the American Meteor Society by Prof. J. Hugh Pruett, University of Oregon, and independently by Prof. C. C. Wylie, Iowa State University, working under a grant from Office of Naval Research. All these reports were turned over to the undersigned, and this paper contains the results. The object began at a height of 132 km., ended at 14., with a path length of 194 km. It moved with direct motion and its orbit had a small inclination. Remarks will be made as to how members of the Academy can aid in similar work.

BUSINESS MEETING

The following officers were elected for 1953-1954:

Chairman: L. W. Webb, Jr.

Secretary: H. Y. Loh

Section Editor: I. G. Foster.

MINUTES OF THE SECTION OF BACTERIOLOGY [3]

W. FRENCH SKINNER, *Chairman*

P. ARNE HANSEN, *Vice-Chairman*

H. J. WELSHIMER, *Secretary*

J. DOUGLAS REID, *Section Editor (1956)*

FRIDAY, MAY 8 - 10:00 A.M. - ROOM 434, MALLORY HALL

1. The Use of Ovotran in Mite Infestations of Laboratory Animals.

James A. Hancock, Jr.; *Medica College of Virginia.*

Stock rats and experimental mice in our laboratory became infested with the tropical rat mite, *Bdellonyssus bacoti* (Hirst). A working sample of a new miticide, "Ovotran" (parachlorophenyl, parachlorobenzene-sulfonate), was obtained from Oow Chemical Company. The infested animals were dusted with a 10% mixture of the active ingredient in talcum powder twice weekly for a total of seven applications. These animals were observed to be free of the parasites after two weeks of treatment, and reinfestation had not occurred three months later.

Since some of the experimental mice were infected with the virus of lymphocytic choriomeningitis, the possibility of the mite serving as a vector of this disease was considered. Transmission of the virus to normal mice by adults and nymphs engorged with the blood of infected animals showing a viremia was not demonstrated either by experimental infestation or by inoculation of ground suspension of the engorged mites.

No toxic symptoms were observed in the animals treated with the miticide.

2. Action of Lysozyme on Several Cell Structures of *Bacillus megaterium*.

H. J. Welshimer; *Medical College of Virginia.*

The action of lysozyme on cells of *Bacillus megaterium* killed with 15% formaldehyde was observed.

The capsule and cell wall substance are attacked by lysozyme, indicating the presence of an acetyl aminopolysaccharide component in these structures.

Chains of bacilli are disrupted by the lysozyme as a result of lysis of the walls of adjoining cells.

3. The Cultivation of *Leptospira* in Chick Embryos.

Catherine M. Russell; *University of Virginia.*

Leptospira icterohemorrhagiae has been cultured in chick embryos, using the allantoic, the yolk sac, and the amniotic routes of inoculation.

Experiments employing 4-, 8-, or 12-day-old embryos revealed that the infectivity of the organisms decreased with the age of the embryos inoculated.

Thirty-seven serial passages of *L. icterohemorrhagiae* in 4- to 6-day-old embryos did not increase or decrease the virulence of the organism for the chick embryo.

4. Primary Isolation of Johne's Bacillus *Mycobacterium paratuberculosis* from Bovine Intestinal Mucosa.

Robert H. Miller and P. Arne Hansen; *Department of Bacteriology and the Live Stock Sanitary Service Laboratory, University of Maryland.*

The success of primary isolation of Johne's bacillus from the bovine intestinal mucosa appears to be increased by the addition of neomycin (8 units per ml.) to the isolating medium. Many organisms found in the intestinal mucosa and acting as contaminants are inactivated by the antibiotic in this concentration, while Johne's bacillus is quite resistant to the neomycin.

Data thus far accumulated indicate that Finlayson's egg medium, in which both brilliant green (0.03%) and neomycin are incorporated, is an efficacious medium for the primary isolation of Johne's bacillus.

5. A Comparison Between Original Lowenstein's Medium and Lowenstein's Modification in the Culture of *Mycobacterium tuberculosis*.

Walter J. Williams, John W. Pond, and Jo Soles; *City Health Department Laboratory, Richmond;* and Geraldine Paul; *University of Richmond.*

In the comparison of 240 positive cultures simultaneously cultured on original Lowenstein and on Lowenstein's Modification media, it was found that in 50% of the cases original Lowenstein gave positive cultures whereas the Modification medium gave none. In 12.9% the Lowenstein's Modification gave positive cultures whereas the original did not. In the remaining 37.1% the cultures were positive on both media.

In view of the above, it is felt by the authors that it is highly advisable to include both original Lowenstein and a medium containing a reduced amount of glycerin in the routine culture procedure for the tuberculosis program.

6. The Use of the 24 Hour Egg Count in the Evaluation of Paragonimiasis.

Michael Potter; *Department of Microbiology, School of Medicine, University of Virginia.*

Quantitative studies of egg production of the lung fluke *Paragonimus westermani* provide a means of study of the disease in the human. By

means of a simple technique reliable information can be obtained from patients: information regarding the degree of infestation, the response to therapy, and the natural history of the parasite in the human host. Data regarding these three points are compiled and presented from case material.

BUSINESS MEETING

The following were elected to take office January 1, 1954:

Chairman: P. Arne Hansen

Vice-chairman: H. J. Welshimer

Secretary: William F. Lawrence

A. E. Fuller was elected Alternate Councilor of the Virginia Branch of the Society of American Bacteriologists.

MINUTES OF THE SECTION OF BIOLOGY [4]

H. G. M. JOPSON, *Chairman*

ZOE WELLS CARROLL BLACK, *Vice-Chairman*

VERA B. REMSBURG, *Secretary*

ROBERT T. BRUMFIELD, *Section Editor (1957)*

FRIDAY, MAY 8, 1953 — 9:00 A.M. — ROOM 147, MALLORY HALL

1. The Taxonomic Significance of Megagametogenesis in *Tiarella cordifolia*, L.

John M. Herr; *Washington and Lee University*.

Megagametogenesis in *Tiarella cordifolia* L. follows the normal or polygonum type except for several marked deviations. The polygonum type is considered the most generalized mode of megagametogenesis and is represented in the herbaceous saxifrages by *Saxifraga ligulata*, *S. sponhemica*, *S. cordifolia*, *S. crassifolia*, and *Heuchera brixoides*. Variation from the generalized type occurs in *S. granulata*, *S. virginensis*, *Francoa ramosa*, *Parnassia palustris*, and *Chrysosplenium* in addition to *Tiarella*. From the degree of variation, the present taxonomic position of the variant and generalized saxifrages can be suggested. Thus, on the basis of spore arrangement, the position of *Tiarella cordifolia* is close to that of *S. granulata* and *S. virginensis*, but is apart from these species with regard to the development of the spore. Placing *Chrysosplenium* close to *Tiarella* also seems warranted because of their similarity regarding the extent of the nucellus.

2. Discovery of *Forsstromeria ohioense* in Virginia.

Paul M. Patterson; *Hollins College*.

In 1846 Sullivant issued his exsiccati, *Musci Alleghaniensis*, and the label on No. 89 is a new species, *Leptodon ohioensis* with its description on the label. It was issued again as Nos. 235 and 354 in *Musci Boreali Americani*. It has never been collected since, not even at the type locality. It was found in some abundance on an arbor vitae tree in 1952 at Natural Bridge, and compares well with the type species. Both *Leptodon* and *Forsstromeria* are currently used for the genus to which this species belongs. A study of the nomenclature convinces the writer that the latter is the valid generic name.

3. A Simple Demonstration of the Effect of Heteroauxin on Plant Growth.

Robert T. Brumfield; *Longwood College*.

Sections cut from dandelion scapes and floated on heteroauxin solu-

tions exhibit varying growth responses according to the concentration of heterauxin. For class demonstration a suitable range is 0, 1, 10, and 100 ppm. After 24 hours, the increase in length of sections from scapes bearing buds and those bearing flowers is roughly proportional to the concentration. In general, sections of scapes bearing fruits show the greatest increase in length in the lower concentrations but the results are not so consistent as is the case with sections of scapes bearing buds of flowers. In a class exercise the instructor may call attention to the possible mechanism of control of scape length in the intact plant.

4. The Sex Chromosomes of the Domestic Cat.

L. Husted and George Walker; *University of Virginia*.

A study of the spermatogonial divisions in the cat, *Felis domestica*, has shown 38 chromosomes. Morphologically distinguishable x and y chromosomes of the type recently reported by Makino and Tateishi are not found in the individual examined. The x and y chromosomes at metaphase I are associated as a rod bivalent by a single chiasma less frequently and as a ring bivalents with two chiasmata more frequently than found by Koller.

5. A Study of the Cyclic Behavior of the Testis of *Cambarus longulus longulus* Girard, with Notes on the Juvenile Males.

Vera B. Remsberg; *Longwood College*.

The three-lobed testis was found to undergo two cycles of sperm production. One occurred from May to September and the other from October to May. This was based on the examination of 389 specimens. All stages of spermatogenesis were obtained during the summer cycle. The diploid chromosome number is probably 196. The sperm is non-motile and possesses five or six rays which unfurl like a pin-wheel in water. The only correlation between the cyclic behavior of the testis and dimorphism in males was seen in the greater quantity of sperm produced by form II males.

6. Bernard Mikula's Collection of Mosses in Virginia.

Paul M. Patterson; *Hollins College*.

In collections over the State, principally of seed plants, Mr. Mikula, in conjunction with field work on a problem in graduate studies at the College of William and Mary made approximately 750 collections of bryophytes during the summers of 1949-52 in 36 counties in all of the physiographic provinces of the State. Collections of *Sphagnum* were well represented. New county records were obtained for a number of the rarer hepaticas, peatmosses, and mosses. Reported in the state for the first time are *Polytrichum commune* var. *perigoniale* and *Sphagnum cuspidatum* var. *serrulatum*.

7. Apparent Competition Between Two Groups of Crayfishes in the Southeastern States.

Horton H. Hobbs, Jr.; *University of Virginia*.

While several instances of the more primitive crayfishes occupying the peripheral range of the genus *Procambarus* may be cited, one of the most precise examples involves the geographical relationships of two groups which inhabit lotic situations in the southeastern Piedmont and Coastal Plain provinces. The members of the less specialized *Pictus* Group occupy a discontinuous range which lies, for the most part, in the younger Coastal Plain, while the members of the more advanced *Spiculifer* Group are more abundant in the older Piedmont Province. In certain areas in the Coastal Plain, however, the latter appears to have invaded the peripheral zone and to have replaced the primitive *Pictus* stock. In relatively few streams are representatives of both groups found together.

8. Observations on Testicular Behavior in the Crayfish, *Cambarus montanus acuminatus* Faxon.

Benjamin H. Word Jr.; *University of Virginia*.

The three-lobed testis of the crayfish is similar in organization to that of other compound alveolar glands. Within the terminal acini, the spermatogonia undergo the usual mitotic and meiotic division to produce non-motile spermatozoa. The latter appear to be discharged from the acini into the collecting tubules by the action of certain peripheral syncytial masses within each acinus. Following the discharge of the spermatozoa, the acinus disintegrates. In the meantime, there has been a proliferation of additional acini from the functional collecting tubules, and here a new cycle of spermatogenesis is initiated.

9. The Effect of Indole-3-Acetic Acid on Regeneration and Spore Germination in Mosses.

Suzanne Scollard; *Hollins College*.

Scant data were obtained on the regeneration of sporophytes in a number of species due to the molding and decay of setae. However, *Mnium cuspidatum* developed from half-mature to completely-mature sporophytes on 100-200 ppm. indole acetic acid agar without regenerating protonema. With spores of *Funaria hygrometrica* and *Scapania nemerosa* on mineral agar media containing indole acetic acid above 50 ppm., spore germination was completely inhibited. With concentrations of 5, 10, and 25, ppm., however, germination and protonemal development were strikingly accelerated, the optimum occurring at 5 ppm.

10. Aquatic Plant Life in Virginia.

A. B. Massey; *Virginia Polytechnic Institute*.

Plant life in water and wet situations is of importance in our economy. Vegetation of this type has a prime influence on the life of waterfowl as a source of food. This is of specific importance in the Virginia Coastal Plain area along the major flyways of the migratory species. Also, such plants are sources of food and shelter for certain species of non-game birds and mammals which inhabit marshes, swamps, or shores. On the other hand, aquatic and semi-aquatic plants are of significance in soil building and in reducing, if not preventing, erosion. In fish ponds some of the aquatic plants are a source of food and shelter for fish; however, the plants in ponds must be kept under control or they will become a menace. This is a preliminary report of a study of the kind of plants to be found in wet habitats, their distribution and abundance in the State. An annotated check list is in preparation.

11. The Nature of the Rhabdites in *Stenostomum virginianum*.

E. W. Pullen; *University of Virginia*.

Preliminary work, which seemed to indicate a relationship between rhabdites and the adhesive hull commonly found about this rhabdocoel, prompted experimentation to determine the nature of the rhabdite and its significance. Well developed single- and double-zooid individuals were stained in Bismarck brown and then agitated severely, fixed, and sectioned. The fixation of these experimental animals was excellent and they exhibited an epidermis which contained reddish-brown rhabdites. The control animals, on the other hand, were not vitally stained but were taken directly from the culture medium and were treated precisely as were the stained animals. The control animals had a thick mucous envelope about each animal and the fixation was poor; no rhabdites were visible. It appears that in the experimental animals, the rhabdites were bound by the vital stain so as to be ineffective in secretion while in the control animals, mucous material was produced. The observations strongly indicate that rhabdites are mucous organelles of the epidermal cells proper, and that these intracellular bodies are responsible for mucous production in this Turbellarian. These conclusions are further supported by the positive staining of rhabdites with mucin-specific stains.

12. The Spermatogenesis of Two Hematotaeniid Cestodes.

Lee T. Douglas; *Emory and Henry College*.

Previous information available on spermatogenesis in cestodes is meager. The present study, based on two undescribed cyclophyllidean cestodes of the Nematotaeniidae, has shown that about sixteen spermatogonia fuse to form a cytophoric syncytium. Immediately after fusion, the prophase of the first maturation division begins. Maturation in all of the spermatocyte nuclei associated with one cyphore is simultaneous. During the pro-

metaphase of both matuatiorn divisions, the cytoplasmic bridges joining the primary spermatocytes are obliterated leaving individual spermatocytes to divide separately. In these divisions, the completion of cytokinesis was not observed — instead the spermatocyte nuclei (or spermatid nuclei) rejoin in the early telophase to again form a syncytium. Spermiogenesis is of the common type involving three centrioles and the development of a midpiece spiral from a filament (probably mitochondrial in origin). The only unusual feature of spermiogenesis is the elongation of the spermatid nucleus to the point that it appears filamentous in the mature spermatozoan.

13. Notes on the Occurrence of *Neoechinorhyncus cylindratus* in Fishes of Westhampton Lake.

Harry L. Holloway, Jr.; *University of Virginia*.

A study of specimens of *Neoechinorhyncus cylindratus* Van Cleave isolated from the alimentary canal of fishes belonging to the families Centrarchidae and Percidae indicate that *Micropterus salmoides* (Lacepede) is the natural definitive host. The relationship of this parasite to its "definitive" hosts is apparently somewhat generalized, at least to the degree that it may find "lodging" in two of the four families of fishes present in Westhampton Lake which were examined. Infections with this parasite, other than in the large-mouthed bass, seem to indicate an imperfect adjustment between host and parasite.

14. Curvatures in Timothy Roots Induced by Ultraviolet Radiation.

Robert T. Brumfield; *Longwood College*.

Primary roots of timothy seedlings exposed to ultraviolet (2537) radiation exhibit curvatures. Exposure to 96,000 ergs/cm.² induced a curvature away from the source and reached a maximum about 60 minutes after radiation. The center of the curvature was about 1 mm. behind the root apex. Dosages of 192,000 ergs/cm.² induced two curvatures. A curvature toward the source occurred soon after irradiation and reached a maximum in about 40 minutes, the center of the curvature being about 1 mm. behind the root apex. A second curvature away from the source occurred later, reaching a maximum about 80 minutes after irradiation. The second curvature was closer to the root apex than the first, the center of the second being about 0.5 mm. behind the root apex.

BUSINESS MEETING

At the business meeting of the Section of Biology, the following officers were elected, to serve for the year 1953-1954.

Chairman: Zoe Wells Carroll Black

Vice-chairman: Vera B. Remsburg

Secretary: Kenneth P. Stevens

MINUTES OF THE SECTION OF CHEMISTRY [5]

HENRY LEIDHEISER, JR., *Chairman*

ROBERT C. KRUG, *Secretary*

CARL J. LIKES, *Section Editor (1957)*

FRIDAY, MAY 8 - 9:00 A.M. - ROOM 102, MAURY-BROOKE HALL

INTRODUCTORY REMARKS. Chairman Henry Leidheiser, Jr.;
Virginia Institute for Scientific Research, Richmond.

1. The Phase Transformation of Cobalt as Observed on Single Crystals.
Victor J. Kehrer, Jr. and Henry Leidheiser, Jr.; *Virginia Institute for Scientific Research, Richmond.*

Cobalt undergoes a crystalline transformation from the low-temperature hexagonal close-packed structure to the high-temperature face-centered cubic structure at 420° C. Single crystal spheres of cobalt were heated and cooled through this transformation temperature and were found to retain their single crystalline nature. The two different structures were determined by the oxidation patterns formed on the crystals.

2. Copper Chelates of Some *beta*-Diketones.

Connie Cole and Helen L. Whidden; *Randolph-Macon Woman's College.*

A spectrophotometric study was made of the copper chelates of 1-cyclopropyl-1,2-butanedione (I) and 1-cyclopropyl-3-phenyl-1,3-propanedione (II), two β -diketones containing the three-membered alicyclic ring. The composition of the complex for I and II was determined by Job's method of continuous variation [Vosburgh and Cooper, *J. Am. Chem. Soc.*, 63, 437 (1941)], and the stability constant for each complex was measured. The pK_D values were compared with values obtained by other investigators for acetylacetone and benzoylacetone. The influence of the cyclopropyl ring on the stability of the chelates of I and II was ascertained from the comparison.

3. An Investigation of *beta*-Amylase of Sweet Potatoes.

Camilla Floyd and Laura Bliss; *Randolph-Macon Woman's College.*

A comparison of the β -amylase activity of commercial "cured" sweet potatoes and untreated sweet potatoes was carried out. It was found

that the curing process, which involved heat treatment for an extended period of time, did not inactivate the β -amylase. β -amylase activity was measured by a determination of the amount of maltose formed by the action of the enzyme on soluble starch. A modified Hagedorn-Jensen was used for the maltose determination.

4. Chromatography in Quantitative Analytical Work.

Margaret Fitzgerald and Helen Whidden; *Randolph-Macon Woman's College.*

The purpose of this paper is to apply theoretical and historical information of chromatographic analysis and its technique to practical quantitative analysis.

Since chromatography is a relatively new method of analysis, its potentialities have not been explored to a great extent in any field of chemistry, and especially not in that of inorganic analysis. The discoverer, Tswett, and most others who have worked with this method have applied it in the field of organic separation and analysis.

The theory of chromatography set forth by Wilson and his approach is used as the basis of the theoretical discussion.

Most of the research upon which the experimental portion of the paper is based has been done with ion exchange resins and aluminum oxide. The setting up of apparatus and the difficulties encountered in the practical approach to this problem is discussed, as well as separations of certain inorganic ions and the quantitative recovery of these as determined by the spectrophotometer and the polarograph.

5. A Microcoulometric Method for the Measurement of the Relative Adsorption of Organic Substances on the Hydrogen Electrode.

Thomas C. Franklin and Ray Sothern; *University of Richmond.*

When two or more substances capable of being adsorbed upon a surface are placed in a solution in contact with that surface there is a competition among the various adsorbates for the available active surface area.

In the experiments performed thus far a platinized platinum electrode has functioned as the adsorbent, while hydrogen plus acetonitrile have been the adsorbates. The amounts of hydrogen adsorbed were determined from current-time curves obtained during the electrolytic oxidation of the adsorbed hydrogen. Upon the addition of a poison to the solution, there was found to be a decrease in the quantity of hydrogen adsorbed commensurate with the quantity of poison added.

6. The Preparation of Some 9-(Dimethylphenyl)-1,2-Benzanthracenes.

Frank A. Vingiello and Alexej Borkovec; *Virginia Polytechnic Institute.*

In connection with our work on an Army Ordnance contract we are preparing a series of 9-(dimethylphenyl)-1,2-benzanthracenes. A discussion of the progress we have made thus far in synthesizing these hydrocarbons is presented.

The Grignard reaction between *o*-chlorobenzaldehyde and *a*-naphthylmagnesium bromide gives 2-chlorophenyl-1-naphthylcarbinol, which is not isolated in the pure form but reduced with red phosphorus and iodine in glacial acetic acid to give 1-(*o*-chlorobenzyl)-naphthalene. This is then converted to the corresponding nitrile, *o*-(1-naphthylmethyl)-benzonitrile, by means of the von Braun reaction. The reaction of the appropriate Grignard reagent on this nitrile, followed by acid hydrolysis, gives dimethyl-2-(1-naphthylmethyl)-benzophenone. The aromatic cyclodehydration of this ketone using a hydrobromic acid-acetic acid mixture gives the corresponding hydrocarbon, 7'-dimethylphenyl) benz-[a]anthracene.

7. Mass Spectrometer Analysis of UO_2F_2 in UF_4 .

Russell Baldock, John R. Sites, L. O. Gilpatrick, and Howard E. Carr; *Oak Ridge National Laboratory*.

A time integration method has been developed for the quantitative analysis of UO_2F_2 contamination in UF_4 . Data are collected from a sample held at constant temperature in the mass spectrometer until the sample is completely used up.

8. The Use of an Anion Exchange Resin for the Isolation of Small Amounts of Zinc.

Richard M. Rush; *Pratt Trace Analysis Laboratory, University of Virginia*.

The use of anion exchange resin (Dowex-1) for the isolation of small amounts of zinc prior to its spectrophotometric determination described.

9. GUEST LECTURE: Emission Spectroscopy in Chemical Analysis.

Ralph E. Thiers; *Pratt Trace Analysis Laboratory, University of Virginia*.

After a brief introduction to the basic ideas and apparatus of spectrochemical analysis there follows a discussion of the impact on analytical chemistry of analytical automations of the "direct-reader" type. This is followed by a discussion of the probable importance of a new type of device called the echelle spectrograph. The paper is illustrated by slides and short movie films.

10. Dithizone Extraction of Sub-Microgram Quantities of Cobalt in the Presence of Ammonia.

John F. Williams; *Pratt Trace Analysis Laboratory, University of Virginia*.

The factors affecting and the difficulties encountered in the dithizone extraction of sub-microgram quantities of cobalt in the presence of ammonia is discussed.

11. Further Study on the Synthesis of Anilino-Methanol.

Joseph E. Sanders, Jr. and Edgar V. Russell; *Virginia Polytechnic Institute*.

The structure of methyl aniline-w-sodium sulfonate as $C_6H_5NH-CH_2SO_3Na$ was verified. Qualitative tests indicate that anilino-methanol is formed, possibly as an intermediate product which loses water forming anilino-methylene which in turn polymerizes.

12. Tetrazolium Chlorides.

A. Garnett Richardson and J. Stanton Pierce; *University of Richmond*.

A series of 2,3,5-trisubstituted tetrazolium chlorides is being prepared for use as tissue indicators in cancer research.

13. A Study of the Methods Used for the Determination of the Rare Earth Elements in Substances containing High Concentrations of Calcium and Phosphorous.

Roger K. Hoover and J. B. Lucas; *Virginia Polytechnic Institute*.

This investigation was undertaken with the following points in mind: to reduce the number of steps involved, to increase accuracy, and to develop a method that could be applied to plant and bone ashes. Many of the methods in use are long and tedious and gave appreciable losses due to coprecipitation.

The method used in this investigation depended on finding the conditions for the minimum solubility of the rare earth oxalates and hydroxides, precipitating them and allowing other elements to go into the filtrate. The solvent used in each case was one to one HCl and the precipitates were washed with 5% solutions of the precipitating reagents.

1. After ashing and dissolving the ash, the solutions were enriched with 25 milligrams of rare earth oxides, diluted to a convenient volume and precipitated with 10% oxalic acid at a pH of 0.7 to 1.0, filtered, washed, and burned to the oxides at 900° C.

2. The oxides were dissolved and the process repeated.

3. The oxides were again dissolved and then precipitated with NH_4OH from 1 M NH_4Cl solution. The hydroxides were filtered, washed, and again dissolved.

4. This process was repeated.

5. The last of the calcium was removed by a batchwise ion exchange treatment using Amberlite IR-120 in a 5% ammonium citrate-citric acid solution at a pH between 3.2 and 3.6.

6. The rare earths were then again precipitated with oxalic acid, filtered, burned, and weighed as the oxides, R_2O_3 .

14. Reactivity of Primary Alkyl Bromides with Thiocyanate Ion.

Thomas I. Crowell; *University of Virginia*.

The rates of reaction of several primary alkyl halides with sodium thiocyanate in 95% alcohol have been measured. A minimum in the rate constant is found at *n*-butyl bromide, the rate increasing with growing chain length until *n*-octyl bromide is reached, which reacts 11% more rapidly than *n*-butyl bromide. This phenomenon is shown not to be a medium effect. Isohexyl bromide, which is as reactive as *n*-hexyl bromide, is the smallest branched-chain molecule not to show considerable steric hindrance in this type of displacement reaction.

15. Solubilities of Some Inorganic Salts in Hydrogen Peroxide-Water Mixtures.

John D. Floyd and Paul M. Gross, Jr.; *University of Virginia*.

Solubility determinations have been made on the following salts at 0°, 15° and 25° C: NaCl, NaF, NaNO₃, KCl, KNO₃, and LiNO₃. These measurements were made as part of a program to study the solvent properties of liquids of high dielectric constant and mixtures of these liquids.

The results of these determinations have been correlated with such properties as: ionic radii of solute particles, dielectric constant of solvent, heats of solvation or solution of the solute, and the effective size of the solvating molecule.

16. Electrodeposition of Aluminum.

Nelson F. Murphy; *Virginia Polytechnic Institute*.

The threat to our sources of tin has stimulated research on plating with aluminum. Several processes have been suggested which might have commercial significance. Organic solutions have shown promise, and use of molten mixtures of sodium chloride and aluminum chloride are being developed. There is need for improvement in the properties of both the bath and the deposit. Some addition agents have been discovered which improve the quality of the product and the speed of deposit.

17. The Electric Dipole Moments of Some N-Monosubstituted Benzamides.

James E. Worsham, Jr. and Marcus E. Hobbs; *Duke University*.

The dielectric constants and densities of dilute benzene solutions of a series of seven *n*-monosubstituted benzamides were measured and the

electric dipole moments calculated. The data were examined by inter-comparison of the results of this series and by comparison with the results of a series of unsubstituted amides previously measured by Bates and Hobbs (*J. Am. Chem. Soc.* 73, 2151, 1951) in this laboratory.

The results indicates a preferred orientation of the substituent group such that the N-H bond of the amide group is "trans" to the carbonyl bond. Additionally, it was observed that the association which occurred with the monosubstituted amides was a linear alignment of the dipoles as opposed to the cyclic association found by Bates and Hobbs [*J. Am. Chem. Soc.* 74, 746 (1952)] for the unsubstituted amides in dilute benzene solutions.

18. Powder Formation During the Catalytic Reaction of Hydrogen and Oxygen on a Copper Single Crystal.

Bruce Wagner, Jr.; *University of Virginia*.

Previous investigations in this laboratory [Leidheiser and Gwathmey, *J. Amer. Chem. Soc.*, 70, 1200 (1948)] have indicated that a copper single crystal forms a powder on the surface while undergoing the catalytic reaction of hydrogen and oxygen. Further study of this reaction has shown that this powder forms preferentially on the surface.

Powder formation is the result of a violent surface rearrangement during which macroscopic particles are formed on the initial surface.

Some proposed mechanisms for powder formation are discussed.

19. A Proposed Mechanism of Catalytic Rearrangement of Metal Surfaces.

R. E. Cunningham; *University of Virginia*.

Observation of catalytic rearrangement of metal single crystals has led to several conclusions, on the basis of which a theory of surface rearrangement is proposed. This concerns itself with the effect of the reaction energy, considering the geometry of the crystal-surface.

The relationship between catalytic surface rearrangement and the preparation, inductive procedures, and use of promotors in catalysis is considered.

20. Some New Color Reactions for Trace Quantities of Boron.

Robert L. Grob; *Pratt Trace Analysis Laboratory, University of Virginia*.

A progress report will be made on a search for sensitive color reactions that may be employed in the development of a method for the determination of microgram quantities of boron.

21. Some New Sensitive Color Reactions of Magnesium.

Charles K. Mann; *Pratt Trace Analysis Laboratory, University of Virginia*.

Some seventy-five compounds were selected from about 1400 dye-stuffs and their color-lakes with magnesium hydroxide were observed. Several of these yield bright colored lakes which offer promise as being useful reagents in the development of a sensitive colorimetric method for magnesium.

22. Some Errors in a Standard Gravimetric Procedure for the Determination of Sulfur in an Iron Ore.

William E. Shitehurst and Edgar V. Russell; *Virginia Polytechnic Institute*.

Samples of an iron ore were analyzed for sulfur by a standard gravimetric procedure and the barium sulfate was analyzed for impurities. Aluminum, silicon lead and calcium coprecipitated with the barium sulfate to a small extent. The occurrence and elimination of these errors are discussed.

23. Charles and Boyle's Law Apparatus for General Chemistry.

N. W. Allen and H. Ritchey; *Virginia Military Institute*.

A relatively simple apparatus that can be made for accurate results in illustrating Charles and Boyle's law in the General Chemistry laboratory has been devised. The average error of the students is about 0.312 per cent.

24. A Mathematical Analysis of Errors Involved in Reducing Sedimentation Constants to Water at 20° C.

Carl J. Likes; *Virginia Institute for Scientific Research*.

In order to compare the sedimentation rates of macromolecular substances under standard conditions it is customary to reduce experimental values of the sedimentation constant to water at 20° C. In cases where the experimental conditions differ markedly from those of the chosen reference state it will be shown that S°_{20} values computed by means of the standard reduction equation lose some significance unless consideration is given to possible changes in the size and shape of the sedimenting particles.

25. The Preparation of Some 9-(Dimethylphenyl)-Anthracenes.

Frank A. Vingiello and Edward Kramer; *Virginia Polytechnic Institute*.

In connection with our work on an Army Ordnance contract we are preparing a series of 9-(dimethylphenyl)-anthracenes. We will discuss the progress we have made thus far in synthesizing these hydrocarbons.

o-Chlorodiphenylmethane is prepared by the Friedel-Crafts reaction between benzene and *o*-chlorobenzyl chloride using aluminum chloride as the catalyst. This is then converted into the corresponding nitrile, *o*-benzy-

benzonitrile by means of the von Braun reaction. The reaction of the appropriate Grignard reagent on this nitrile, followed by acid hydrolysis, gives 2'-benzylidimethylbenzophenone. The aromatic cyclodehydration of this ketone using a hydrobromic acid acetic acid mixture gives the corresponding hydrocarbon, 9-(dimethylphenyl)-anthracene.

26. Trimethylchlorosilane Derivatives of Organolithium Compounds.

F. M. Braswell and H. Ritchey; *Virginia Military Institute*.

Trimethyl, 2-pyridylsilane was prepared by reacting 2-lithopyridine in an ether solution with trimethyl-chlorosilane. The turbid mixture is placed in a separatory funnel and water is added with shaking until two colorless layers result. The desired product is in the ether solution. The distilled product is a light brown liquid which boils at approximately 191° C.

27. A New Colorimetric Method for the Determination of Uranium.

John H. Yoe, Fritz Will, III, and Robert A. Black; *Pratt Trace Analysis Laboratory, University of Virginia*.

A procedure for the colorimetric determination of uranium (VI) with dibenzoylmethane will be presented. A bright yellow, stable complex is formed when the organic compound reacts with uranyl ions under specified conditions. The color reaction conforms to Beer's law.

28. Controlled Atmospheres in Spectrochemical Analysis.

Ralph E. Thiers; *Pratt Trace Analysis Laboratory, University of Virginia*.

Various effects of atmosphere other than air on spectrochemical techniques with the direct current arc will be discussed. Color slides and a short color movie will be used as illustrations.

29. Henry's Law Constants for Gases at High Temperatures.

Ray C. Elton and D. S. Davis; *Virginia Polytechnic Institute*.

Application of the Lagrange interpolation schedule [Davis, D. S., Chem. Met. Eng., 45 (7) 383 (1938); "Empirical Equations and Nomography", p. 61, New York, McGraw-Hill Book Co., Inc., (1943)] to the Henry's law constants for helium, hydrogen, nitrogen, and oxygen enables reliable estimation of these values over the range of 50° to 650° F. and extends the utility of the original data.

30. The Absolute Entropy of the Chloride Ion.

Elmer S. McKee; *Washington and Lee University*.

By use of a thermocell operating between small temperature differences, it is possible to determine the change in entropy occurring in a half reaction. If only one ion is involved in this reaction, e.g., in the reaction:

$Hg + Cl = \frac{1}{2} Hg_2Cl_2 + e$ and if the entropy of the electron can be shown to be negligible, then the absolute entropy of the ion can be determined relative to the entropy values of solids as derived from the Third Law of Thermodynamics. This value may then be used directly to calculate potentials of half reactions and other thermodynamic properties, and perhaps, to elucidate the theory of aqueous solutions.

31. The Change of Entropy of the Chloride ion with Concentration and Type of Cation.

Elmer S. McKee and Bentz Howard, Jr.; *Washington and Lee University.*

The effect of concentration and type of cation on the entropy of the chloride ion in concentrated solutions was investigated. Possible explanations for the changes of entropy in these systems are postulated.

32. Distillation of Sea Water.

William H. Caines and Frank C. Vilbrandt; *Virginia Polytechnic Institute.*

A process has been developed whereby sea water is heated for a definite period of time and then aerated to liberate any free carbon dioxide and carbon dioxide released by the decomposition of bicarbonate. This results in the precipitate of calcium carbonate and magnesium basic hydroxide. The precipitate is filtered out and the resulting filtrate neutralized by acidification prior to evaporation in a sea water evaporator. The studies have been made on a laboratory pilot plant belonging to the Coast Guard and the U. S. Navy, to determine the effectiveness of the process in preventing scale formation on-board evaporators. Results of the tests have been graphed on a number of evaluations of the processing. The maximum reduction was 70% in the quantity of scale formed when processed under limited conditions.

33. Scientific Vocations—A Survey of Promotional Materials.

Dr. Lowell V. Heisey; *Bridgewater College.*

According to reports from many sources, our nation is being faced with an unprecedented shortage of scientifically trained personnel during the next decade. This paper discusses some of the possible reasons for this shortage and some of the steps being taken for its alleviation by educational institutions, industry, professional societies, and the government.

One of these remedial steps is the publication of an increasing amount of vocational literature for the purpose of acquainting high school students with, and encouraging them to choose vocations in science fields. The author has been making a survey of this type of literature and will present the more outstanding features of some representative examples of these publications.

Also some of the vocational guidance and promotional projects being used in other sections of the country will be discussed, with suggestions for our own area.

34. Evidence for Cis-Trans Configuration and Effective Conjugations of α -Phenylchalcones.

W. Bruce Black and Robert E. Lutz; *University of Virginia.*

Determination and interpretation of the ultraviolet absorption of the cis and trans α -phenylchalcones and of their 2-(4-nitro) and 3-(4-nitro) derivatives have demonstrated the configurations and conformations of the isomers. The conclusion has been drawn that the cis isomers involve effective conjugation of the trans stilbene system only, whereas the trans isomers involve effective contributions of both the cis stilbene and trans chalcone conjugations. The greater reactivity of the trans isomers toward nucleophilic (1,4) additions has been demonstrated and is consistent with and supports this conclusion.

35. Ring-Chain Tautomerism of Substituted Cis- β -Aroylacrylic Acids.

James W. Rinker, Colin L. Brown, and Robert E. Lutz; *University of Virginia.*

Resolution of the ultraviolet absorption spectra of their cyclic and acyclic derivatives show that α and β -phenyl- β benzoylacrylic acids exist in dilute 95% ethanol solutions as equilibrium mixtures of their cyclic and acyclic forms in which the cyclic forms predominate. In the case of α -phenyl- β -benzoyl-acrylic acid, it has been estimated that the equilibrium mixture consists of 70% of the cyclic and 30% of the acyclic forms. In alkaline solution both acids exist as the anions of their more acidic (acyclic) forms while in strongly acidic solution the equilibria lies in favor of the less acidic (cyclic) forms.

Ultraviolet absorption studies on the cis β -aroyl- α -and β -methyl-acrylic acids and related compounds show that the cis compounds in solution are cyclic but are open-chain in the form of the anions. The cis β -benzoyl- α -and β -methyl compounds and both β -aroyl- α -methylene-propionic acids have been made respectively from citraconic and itaconic anhydrides by Friedel-Crafts reactions. The structures and configurations have been demonstrated. The trans isomers are the stable forms; the cis isomers are labile; and the β -aroyl- α -methylenepropionic acids also are labile and the least stable of the three types. Interconversions of the various isomers are described.

BUSINESS MEETING

A nominating committee, consisting of H. Rupert Hanmer, Alfred R. Armstrong, and Lowell V. Heisey, nominated the following candidates for

officers of the Section of Chemistry for 1953-1954:

Chairman: Robert C. Krug

Secretary: J. Stanton Pierce

These officers were elected by a unanimous vote of the members present.

MINUTES OF THE SECTION OF EDUCATION [6]

JACK H. BOGER, *Chairman*

JOS. N. PAYNE, *Secretary*

F. G. LANKFORD, JR., *Section Editor (1956)*

FRIDAY, MAY 8, 1953 — 9:30 A.M. — ROOM 454, MALLORY HALL

1. Science Teaching in Virginia High Schools.

Percy H. Warren; *Madison College*.

The purpose of this study was to present data concerning the science offerings of Virginia high schools and the combinations of science subjects taught by teachers who were teaching one or more classes in science during the school years of 1946-47, of 1949-50, and of 1951-52. All of the data used were obtained from original sources in the files of the Virginia State Department of Education.

More than 50 per cent of the high schools in Virginia have a minimum science offerings of general science, biology, and chemistry. Notwithstanding this fact, more than 50 per cent of the teachers who taught one or more classes in science taught only one or two science classes. More than 60 per cent taught only one science and more than 85 per cent of the teachers taught no more than two classes in science. This is not a desirable situation for it appears that, in general, teachers who are giving the major portion of their instructional time to other subjects will not do superior teaching in science.

More than 95 per cent of the high schools offer instruction in general science. More than fifty per cent of the science teachers in this study taught this subject.

Instruction in physics is not available to youth in 80 per cent of the high schools of Virginia. High school principals frequently say that they would like to offer physics but are unable to obtain properly qualified teachers for this subject. The institutions responsible for the education of teachers in Virginia should formulate plans for the education of science teachers who are competent in the field of physics.

2. A Study of the Opportunities for Employment in Industry in the Norfolk Area of Virginia.

W. E. Lobeck; *Norfolk City Public Schools*.

The writer, being responsible for administering the Vocational Educational program of the Norfolk City Public Schools, was confronted with the lack of information regarding employment opportunities and training needs in the area. Previous surveys indicated a need for further study.

This study was set up to determine as far as possible the exact nature of these opportunities and needs.

The survey was limited to industrial firms employing fifteen or more workers and government installations. The industrial firms were grouped into three general categories; building trades, construction, installation and service; transportation, manufacturing and commercial output; and processing and manufacturing of commercial foods. Data were gathered on check sheets through personal interviews. The survey forms were in two parts, one for general information pertaining to company policies and attitudes toward education and training; and a second part for information about specific jobs.

The survey revealed that government installations employed the greatest number of industrial workers. Firms engaged in transportation, manufacturing and commercial output had the greatest number of non-government workers; building trades' ranked second in employment, notwithstanding the slack winter months. Commercial food firms had the lowest number of employees with Negroes predominating. The mechanic-apprentice ratio was below the national level in all groups. All firms had some form of employee retirement and part time employment was used extensively.

The basic training now offered is meeting some of the demands of industry. It appears, however, that steps should be taken to broaden the program in an attempt to meet a larger number of the employment requirements.

3. A Study of the Academic Success of Virginia's College Freshmen Who Enrolled in the State's Institutions of Higher Learning During the Fall of 1948.

Alfred L. Wingo; *State Department of Education, Richmond.*

It was the purpose of this study: to find relationships of the size of the enrollments in Virginia's public high schools to the academic success of the graduates of these schools as freshmen in the State's institutions of higher education; to find the extent to which freshmen students dropped out of college in Virginias' institutions of higher education; to identify the courses where the extremes in success and failure occurred; and to compare the academic records of Virginia's public high school graduates with the records made by graduates of public secondary schools outside the State and private secondary schools inside and outside the State.

The data tabulated were provided by the Registrars of twenty-two of the State's institutions of higher learning for whites and two for Negroes. These data were recorded by college personnel on cards for individual students.

Of Virginia's high school graduates 12.0% of the white students and 14.2% of the Negro students dropped out of college during the first year. The percentages of students who dropped out of college from public high schools outside the State, private secondary schools inside the State,

and private secondary schools outside the State were 10.2, 17.6, and 10.3 respectively.

There is a slight overall trend with respect to student-semesters passed in favor of the larger high schools. The overall student-semester passing percentages for the five groups of secondary schools arranged in descending order are as follows:

Public High Schools outside Virginia	91.6%
Public Negro High Schools in Virginia	89.1%
Public White High Schools in Virginia	87.3%
Private Secondary Schools outside Virginia	84.5%
Private Secondary Schools in Virginia	83.2%

For white students the student-semester passing percentages ranged from 99.3 for home economic courses to 79.8 for mathematics courses. The range for Negro students is 100% each in home economics and in religion down to 64.4% for courses in mathematics.

The lowest passing percentage (71.1) for Private Secondary Schools inside the State is in foreign languages, and the highest passing percentage (94.3) for Private Secondary Schools outside the State is in military sciences.

4. Academic Aptitude Testing of Freshmen at Longwood College.

M. Boyd Coyner; *Longwood College*.

For thirty years Freshmen entering Longwood College have been given the *Otis Test of Mental Ability: Higher Examination*, which is considered a fairly good test of academic aptitude. Records of medians and percentiles have been kept. In 1947 the College began a new program of more careful selection of students for admission than had previously been used.

Comparisons of records under the new program with those previous thereto show considerable improvement in the general level of ability to do academic work: about one-fourth of present admissions are below the median score on the Otis Test secured by earlier admissions, and about one-tenth of present admissions are below the Q_3 score of earlier admissions.

As to the validity of the Otis Test, correlation with academic records cluster around +.50. The "Dean's List" for the current semester contains eight times as many from the upper half of the class, as measured by the Otis Test, as from the lower half of the class.

The Otis Test has been administered recently to 75 Sophomores. Correlation with Freshman scores is +.82. The average change in scores is an addition of less than three points, and 72% of the cases changed five points or less. The highest possible score on the test is 75 points.

5. A Study of Certain High School Graduates in Relation to Their Elementary School Origins.

George G. Richards, Jr.; *Weller Baker School, Cambria, Virginia.*

Schools in the Blacksburg Magisterial District of Montgomery County, Virginia provided the data for this study. The Town of Blacksburg and its environs constituted what was deemed to be a typical college community, since it appeared that the educational and cultural life of the Magisterial District was built around Virginia Polytechnic Institute, its Experiment Station, and its Extension Division.

The schools included in this study were the Blacksburg High School and the ten elementary schools from which pupils were promoted to that school. Particular attention was limited to the 86 pupils who were graduated from the High School at the end of the 1950-51 term.

The purpose of this research was to discover what relations, if any, there were between elementary school origins of the students and their ratings in high school. These ratings included grade averages, parents' education, intelligence quotients, co-curricular activities as indicated by membership, co-curricular activities as indicated by office holding, ages, absences, and the A.C.E. Psychological Examination scores.

The data were arranged in four groups, designated according to the several distances of pupils' homes from Blacksburg. The data were also organized in terms of individual schools. Coefficients of correlation of the zero, first, and second orders were computed, as between various traits studied.

Two salient findings, relative to the population under investigation, emerged from this study:

- (a) Academic success in high school tended to be determined by native ability rather than by distance travelled.
- (b) Participation in co-curricular activities tended to be strongly and adversely affected by such travel.

6. A Study of the Certification of Science Teachers in Virginia.

John B. Chase; *University of Virginia.*

It was the purpose of this study to (1) determine the types of science jobs that are most prevalent in Virginia, (2) ascertain the opinions of school administrators in Virginia about the present certification requirements for science teachers in Virginia, (3) study and compare the basis for certification in those states which have requirements comparable to or higher than those now existing in Virginia, and (4) make recommendations based upon the conclusions of the study for the improvement of the certification of science teachers in Virginia.

A study of the responses of 114 (91.2%) Virginia superintendents to a questionnaire indicates that the vast majority of science vacancies calls

for certification in at least three of the sciences. In general, state certification requirements do not demand the breadth of training that seems to be desirable. Superintendents feel that a single endorsement for the field of science rather than the present plan of separate endorsements would be desirable. The findings of this study confirm the fact that certification should reflect competence in subject matter; hence, it is recommended that prospective teachers of science should have introductory courses in the three sciences of biology, chemistry, and physics with additional courses totaling at least 24 semester hours in one field and at least 18 semester hours in the others.

The findings and recommendations call for further study of the organization and methodology used in science courses at the college level taken by prospective science teachers. They should be trained and certified to integrate the various sciences and to teach social, economic, and political relationships which exist in scientific development and progress. A constant and closer working relationship between certification agencies and institutions planning programs for the training of teachers of science should exist. Providing sufficient and capable teachers of science requires the best cooperative effort of all concerned — schools of education, departments of science, scientific organizations and state agencies.

7. Developing A Functional Program in Nursery School Education.

Alvia L. Bozeman; *Virginia State College*.

This paper deals with the nursery school at Virginia State College. A brief statement of the history of the nursery school is given. Emphasis, however, is placed upon its contemporary status. The objectives, including research in the field of child development are outlined. The facilities and personnel are given and methods of implementing the program are indicated.

The discussions make it clear that the nursery school is designed to meet the needs recognized as fundamental in the lives of pre-school children. In particular, emphasis is placed upon the prevention of the development of personality abnormalities.

The nursery school serves not only the children, but it also serves as a place where parents may observe their children in a social situation different from that of the home. For students in subject areas concerned with the development of children, it provides a place for observation of the phenomena considered of consequence in the general area of child growth. Its excellent facilities for research are available to persons working in this or related areas.

Testing appropriate for this level is conducted and records of pertinent data are kept and used for a wide variety of purposes consistent with the maximum development of the child and for conferences with parents.

8. Guidance Programs in Virginia Colleges.

W. Donald Clague; *Birdgewater College*.

This study was an attempt to determine the organization and general practices in guidance in the four-year colleges and universities in Virginia, and to compare the findings in these areas with those considered desirable by authorities in the field of guidance. The data were gathered by personal visits to colleges, study of catalogs, use of a questionnaire, and abstraction of other studies.

The following are some of the conclusions and recommendations which resulted from the study and comparison with the literature on guidance;

1. Administrators in Virginia colleges and universities are becoming increasingly guidance conscious. There are some organized guidance services in each of the twenty-one institutions studied.

2. There is need for study and clarification by administrators and guidance personnel of the proper functions of guidance personnel.

3. Both faculty and students are used in guidance in some colleges, but in-service training programs are few, though recognized as helpful.

4. Some form of counseling is available in all the institutions studied; vocational counseling is most often neglected; academic counseling is most often provided.

5. Opportunities for remedial work in reading, etc., are limited though needed. They are being increasingly provided.

6. Adequate vocational placement and follow-up services are not provided in most of the institutions.

7. Systematic evaluation of guidance programs is inadequate in most of the colleges studied.

8. Research activities in the field of guidance are limited and should be expanded.

BUSINESS MEETING

The following officers were elected by the section of Education to serve for the year 1953-1954.

Chairman: Joseph N. Payne

Secretary: John B. Chase, Jr.

MINUTES OF THE SECTION OF ENGINEERING [7]

VICTOR G. SZEBEHELY, *Chairman*

ROBERT W. TRUITT, *Secretary*

NELSON F. MURPHY, *Section Editor (1953)*

FRIDAY, MAY 8, and SATURDAY, MAY 9 - 9:00 A.M. - ROOM 105,
NICHOLS ENGINEERING HALL

1. Engineering Aspects of Nuclear Energy.

J. M. Morgan, Jr.; *Virginia Military Institute.*

A brief history is given of the development of nuclear energy from Curie to the present. Structural damage and the reason therefor in the two Japanese target cities, including that done by fire and blast, are described. A discussion is given of (1) some building materials as a shield from radioactivity, (2) increase in size of explosion and the resulting effect on materials, and (3) the disposal of radioactive waste as an engineering problem.

2. Analogies Based upon the Two-Dimensional Poisson's Equation.

James G. McGinley; *Virginia Polytechnic Institute.*

There are various two-dimensional physical phenomena that are governed by the mathematical relationship known as Poisson's Equation. Some of these are (1) the shear stress in a prismatical bar subjected to torsion, (2) pressure under a membrane, (3) the heat flow through a body, and (4) electrical flow in a conductor.

Following proper development, based upon this fundamental relationship between these various fields, a comparison can be made between terms of the related phenomena and an analogy drawn. An outstanding example of this technique is the celebrated membrane-shear stress analogy.

This thesis will attempt to connect as many problems as possible involving Poisson's equation, arriving at the exact term by term correlation between the variables in the various problems.

The objective of this effort will be to relate the fields for which solutions have not as yet been determined to those for which solutions have been obtained. A tabulation of the related terms will enable one to transfer from one field to another by a certain conversion factor.

3. Compatibility of Highway Materials.

Philip L. Melville; *Council of Highway Investigation and Research, University of Virginia.*

It is common practice to consider a number of materials used in construction as being "inert." For instance, in a Portland cement concrete mix the aggregate is designated as the inert part in opposition to the binding medium, commonly described as the active phase. It is well known that from a true chemical-physical point of view no substance can be absolutely inert, and the term is usually employed with a relative meaning. In recent years cases of concrete distintegration have brought to light such phenomena as: high-alkali cement-siliceous aggregate reaction, and the deleterious effect of certain cherts in cement concrete. As a result of these occurrences and similar ones with other highway materials, it is believed that it would be advisable to acknowledge more openly the fact that the so-called inert property of a material is a function of surrounding conditions and especially: temperature, moisture, stress-strain conditions, and surrounding media in which a given body is to be placed.

4. An Analog Unit for Demonstrating Process Control Instruments.

R. M. Hubbard; *University of Virginia*.

A description is given of a pneumatic analog instrument for demonstrating on-off, floating, narrow band proportional, and proportional plus reset control instruments. Both simple and difficult controllable processes are included. The unit is also capable of imposing an arbitrary deviation of the variable to the pneumatic control instruments.

5. Model and Prototype Behavior of Engineering Structures.

D. H. Pletta; *Virginia Polytechnic Institute*.

Since the behavior of even the simplest structures is often quite complex, engineers have had to base their designs on simplified analytical assumptions and experimental investigations. Model tests have saved millions of dollars in construction costs but require careful interpretation because of their three-dimensional nature and because of the effect of their size on the physical properties of materials. Experiments indicate that models follow prototype behavior quite well in the elastic range but appear relatively stronger at ultimate loads. The paper describes several such tests on small reinforced concrete models.

6. A Survey of Various Methods of Analysis of Cantilever-Type Plates.

William A. Nash; *David Taylor Model Basin, Navy Department*.

The problem of the bending of thin cantilever-type plates has attracted the attention of investigators only in comparatively recent years. Problems involving the static deformations of thin rectangular and skew cantilever plates subject to various loadings normal to the middle surface of the plate have been investigated by several methods, mostly of an approximate nature. More recently the problem of combined static torsion and bending of a cantilever plate of variable thickness has been treated by the method of minimum potential energy. Also, the static deformations

and stresses in a thin cantilever plate in the form of a sector and clamped along one edge have been obtained by approximate methods.

The problem of the bending of cantilever plates of finite dimensions is extremely difficult to solve from the standpoint of biharmonic analysis because of the unwieldy boundary conditions. To date, only the single problem of the deflection of a thin square cantilever plate subject to uniform normal pressure has been solved by "exact" methods. In all other analyses recourse has been made to approximate methods of analysis.

In this paper the various approximate methods used to treat these problems are examined and compared from the viewpoint of both practicality of use and also mathematical and physical rigor. A rather complete résumé of existing knowledge regarding strength of cantilever-type plates is given, together with a bibliography.

7. An Engineering Evaluation of the Continuity Method for Predicting the Form and Location of Detached Shock Waves for Two-Dimensional Flow.

Perry W. Hanson, *Virginia Polytechnic Institute*.

The continuity method, formulated by W. E. Moeckel, is a theoretical approximate method for predicting the form and location of detached shock waves. Unfortunately, at the time of the publication of this method very few reliable experimental results for flow over two-dimensional, wedge-type airfoils were available for comparison with the theory. With the advent of new interferometric techniques and shock tubes, a great deal of experimental data for supersonic airfoil shapes in the Mach number range slightly greater than unity is now available.

Use is made of these data to investigate more thoroughly the reliability of the continuity method. Moeckel's formulation of the continuity method for two-dimensional wedge-type airfoils is first presented, and a set of parametric curves similar to those presented by Moeckel, but in a more convenient form, is included for the Mach number range under investigation. The form and location of the detached shock waves are then calculated by the continuity method for conditions for which experimental data is available. The theoretical and experimental shock waves are compared, and the continuity method evaluated for engineering usage.

8. The Two-Dimensional Subsonic Compressible Flow Over a Joukowski Airfoil.

Y. K. Pien and E. S. Cornette; *Virginia Polytechnic Institute*.

The fundamental equations of fluid motion are non-linear partial differential equations. As yet, a general method for the treatment of non-linear partial differential equations does not exist. There have, however, been advanced two possible methods of attacking the problem of two-dimensional, steady, irrotational, compressible flow, as follows:

- (a) to approximate to the exact non-linear equation by linear differential equations (small perturbation theory);
- (b) to try to find a transformation of variables which transforms the exact non-linear equations into exact linear equations.

The second of these two methods, when applied to problems of fluid flow, is known as the Hodograph Method.

In the original non-linear equations of motion, the velocity components are the dependent variables, and the coordinates are the independent variables. In the Hodograph transformation these equations are transformed into exact linear differential equations in which the velocity components become the independent variables.

Th. von Karman and H. S. Tsien have shown, by a simplification of the exact linear Hodograph equations, that these equations reduce to the Cauchy-Riemann differential equations. In solving the Cauchy-Riemann differential equations for a compressible fluid, any analytic function may be used as the solution, but the difficulty lies in satisfying the boundary conditions in the physical plane. However, since the equations of motion in the Hodograph plane for an incompressible fluid are of the same mathematical type as those for a compressible fluid, Karman and Tsien have shown that one may use the known solution for the incompressible fluid as the sought solution for the compressible fluid. That is, the Karman-Tsien method allows one to obtain an approximate compressible flow solution by using a known incompressible flow solution.

It is the purpose of this paper to obtain the approximate solution of the compressible flow over a symmetrical Joukowsky airfoil by employing the Hodograph Method in conjunction with the simplification made by Karman and Tsien.

9. Aerodynamic Effects on a Body Immersed in a Non-Uniform Flow.

Joseph L. Hendricks, Jr.; *Virginia Polytechnic Institute*.

The usual theoretical analysis performed to determine the pressure distribution on a body assumes that the flow far ahead of the body is uniform, irrotational, and incompressible. There are cases, however, in which the flow is not uniform. Examples of this condition are the flow behind a wing and the subsonic compressible flow behind a detached shock wave.

This paper, then, is concerned with determining experimentally the pressure distribution resulting from a non-uniform velocity distribution. An expression for the pressure coefficient on a cylinder in a parabolic velocity distribution has been derived by Henry T. Nagamatsu in his doctoral thesis on detached shock waves. The theoretical pressure coefficient will be compared with the pressure coefficient obtained experimentally in the wind tunnel having a predetermined curvilinear velocity distribution. Preliminary investigations indicate that the velocity distribution in the test section can be altered (successively).

A final objective is to determine if there is some uniform flow that will cause the same pressure distribution on a cylinder as the non-uniform velocity distribution.

10. Line Coordinate Chart for the Viscosity of Aqueous Glycerin.

Richard E. Herron and D. S. Davis; *Virginia Polytechnic Institute*.

New data, which deal with viscosities of aqueous solutions of glycerin that contain from 9.5% to 95% glycerin at temperatures from 20° to 50° C., are correlated by means of the equation

$$\log \mu = a/(t + 230) + b$$

where μ is the viscosity in centipoises, t is the temperature in degrees centigrade, and a and b depend upon the concentration. A line coordinate chart enables rapid and accurate solution of the equation, provides for easy interpolation along closely graduated scales, and agrees well with a previous nomograph (Davis, D. S., *Chem. Eng.*, 59 [4] 178, 1952).

11. The Effect of Operating Variables on Overhead Vapors and Residues from a Continuous Flash Distillation of Methanol-Water.

Charles E. Littlejohn and Frank C. Vilbrandt; *Virginia Polytechnic Institute*.

The system methanol-water was flash distilled in a nine-inch-diameter electrically heated still, 14 inches high, under a condition of paddle agitation with a hold-up of 445 cubic inches. The vaporizing temperatures were 172°, 166°, and 162° F.; stirrer speeds were zero, 500, 1000, 1500, and 2000 r.p.m.; feed rates were 0.01 to 0.05 pounds per minute.

The fraction vaporized was a function of the feed rate:

$$Z = K_1(R_1 - R_2)^{-b}$$

where Z is the fraction vaporized, K_1 is the fraction vaporized when the term $(R_1 - R_2)$ is equal to one, R_1 is the feed rate in pounds per minute, R_2 is the feed rate when the residue rate is equal to zero, and b is a constant for a given temperature and stirrer speed. Z was directly proportional to stirrer speed and the vaporizing temperature, varying between 1.0 and 0.04.

The composition of the distillate was an exponential function of the feed rate:

$$X_D = K_2(R_1 - R_2)^a$$

where X_D represents the distillation composition, weight percent of methanol, K_2 represents the distillation rate when $(R_1 - R_2)$ equals one, R_2 is the feed rate when the residue rate is equal to one, and a is a constant for a given temperature and stirrer speed.

The expression

$$N = \frac{X_D}{X_S} \times K_s (nt_h)^d$$

for dynamic equilibrium ratios, where X_S is the composition of the liquid in the still at equilibrium as weight percent methanol, n is the stirrer speed in r.p.m., t_h is hold-up time in minutes, and K_s and d are constants for a given temperature.

12. Design, Construction, and Operation of a Continuous Pilot Plant Hypersorption Unit for Vapor Phase Separation of CS_2 and H_2S .

Seymour S. Stein and Frank C. Vilbrandt; *Virginia Polytechnic Institute*.

The continuous hypersorption unit consists of two major heat transfer sections of 13.42 square feet each separated by adsorption and rectifying sections, the latter consisting of 2 inch standard pipe, 13 feet long. A gas lift system was incorporated for recirculating the carbon from the bottom of the unit to the top.

Adsorption activities of 59.40%, 37.01%, 23.56%, 12.89%, and 2.05% were obtained for activated carbon, silica gel, sovabeads, activated alumina, and filtol, respectively, at 30° C. for an air flow rate of 1560 milliletriper minutes. Retentierties of 2.93%, 0.54%, 3.05%, and 3.65% were obtained for activated carbon, sovabeads, activated alumina, and silica gel, respectively, at 30° C. for an air flow rate of 780 milliliters per minute.

Pure isotherms were obtained at 33°, 50°, 75°, 100°, and 140° C. for hydrogen sulfide and at 50°, 75°, 100°, and 140° C. for carbon disulfide, at pressures of 11.4 to 726.0 millimeters of mercury.

The ratio of carbon disulfide to hydrogen sulfide absorbed at a pressure of 760 millimeters of mercury was 4.10, 6.08, 7.88, and 9.30 at temperatures of 50°, 75°, 100°, and 140° C.

13. Operating and Design Variables in Continuous Liquid Thermal Diffusion.

C. Leo Kingrea and Frank C. Vilbrandt; *Virginia Polytechnic Institute*.

Liquid thermal diffusion may be utilized to enrich a desired component in liquid mixtures; typical examples are the separation of isotopes, the separation of azeotropes, and the separation of hydrocarbons.

The effects of operating and design variables on the enrichment of aqueous sugar solutions were investigated experimentally. Variables considered were feed concentration, operating temperatures, feed and draw-off flow rates, length and width of the diffusion annulus, and the location of feed and draw-off ports.

Experiments were made in a concentric tube type apparatus. This apparatus consisted of a cold wall formed by an inner copper tube, through which tap water was circulated. This tube was concentrically enclosed by a glass tube which formed the hot wall of the diffusion annulus, and this pair was then enclosed by a glass pipe. The hot wall of the diffusion chamber was heated by circulating hot water or by condensing steam in the outer annulus between the glass tube and the glass pipe. The sugar solutions were fed into and drawn from the annulus through suitably arranged ports in the copper tube. The refractive index change between top and bottom samples was used to indicate the amount of enrichment effected.

14. The Relation of Vessel Diameter to Several Properties of Fluidized Beds of Solid Particles.

John E. Lastovica, Jr. and Fred W. Bull; *Virginia Polytechnic Institute.*

An investigation was performed to determine variations in the important physical characteristics of a fluidized bed of solid particles as the diameter of the fluidization vessel was varied. Six pyrex vessels, each four feet long, having internal diameters of 4-, 2-, 1 15/32-, 1-, 3/4-, and 7/16-inch were used. The solid particles chosen were tabular alumina, ottawa sand, crushed sandstone, silica gel, superbrite glass beads, sovabead fines, and a micro-spheroidal cracking catalyst. The fluidizing medium was air. The amount of bed expansion required to permit fluidization was found to be a constant characteristic of each solid. Fluidization ranges increased with increasing vessel diameter. Critical fluid mass velocities approached a minimum value as the vessel diameter was increased, indicating that critical mass velocity might become independent of vessel size as the vessel diameter reached some value greater than four inches. Important characteristics of the solid particles were determined. An equation, including a vessel diameter term, is presented for predicting critical mass velocities and relating the physical properties of beds fluidized at greater than critical mass velocity.

15. Design, Construction, and Calibration of a Small Supersonic Wind Tunnel.

Fred W. Martin and Robert W. Truitt; *Virginia Polytechnic Institute.*

This paper describes the design, construction, and calibration of a relatively inexpensive, undergraduate, blow-down, supersonic wind tunnel. A detailed description is given of the nozzle and working section, including methods of design analysis. Interesting shock wave photographs, which were obtained by a simple and inexpensive schlieren system, are presented. Experimental data are given and discussed for the calibration, and several simple experiments are described.

16. Stresses from Localized Pressure and Irregular Contours within Thick-Walled Vessels (A Proposed Program).

B. A. Niemeier; *Experiment Incorporated, Richmond.*

The limitations in the application of generally accepted formulae for analyzing stresses and strains within thick-walled vessels are discussed. Fragments of tests on a pressure chamber indicate the need for improved design criteria. A series of tests is proposed for attacking the problem of localized high pressure within thick-walled vessels. An experimental procedure to show the effect of varying the outside and/or the inside diameters is also outlined.

BUSINESS MEETING

The officers elected by the Engineering Section for the year 1953-1954 are the following:

Chairman: Robert W. Truitt.

Secretary: Philip L. Melville.

Section Editor: Robert Hubbard.

MINUTES OF THE SECTION OF GEOLOGY [8]

RAYMOND S. EDMUNDSON, *Chairman*

WAYNE E. MOORE, *Vice-Chairman*

WILLIAM T. PARROTT, *Secretary*

BYRON N. COOPER, *Section Editor (1953)*

FRIDAY, MAY 8, 1953 — 9:00 A. M. — ROOM 249, MALLORY HALL

1. Carolina Bays of the Coastal Plain of Virginia.

Allen Sinnott; *District Geologist, Ground Water Branch, U. S. Geological Survey, Charlottesville.*

Examination of photo-index mosaics of aerial photographs taken on the Eastern Shore peninsula in Virginia reveals many oriented, elliptical, shallow depressions with low sand rims — typical examples of the Carolina Bays described from the eastern part of the Carolinas and elsewhere in the Atlantic Coastal Plain from Florida to New Jersey. Prouty's modified meteoric hypothesis of origin is favored. In order to test this hypothesis, magnetometer surveys, and chemical analyses of soils to detect significant traces of nickel, are planned.

2. New Concept of Appalachian Thrust Faults.

Wilbur A. Nelson; *University of Virginia.*

Geological work carried on in Smyth and Washington Counties, Virginia, along the Saltville Fault, supplemented by diamond drilling, has shown the presence of a normal fault near the northwest side of the Saltville Valley, dipping approximately sixty degrees to the southeast and located from 150 to 500 feet northwest of the trace of the Saltville Fault. Drilling was also done for a distance of two miles to the southeast of the trace of the Saltville Fault and this drilling showed that 100 or more feet southwestward from the trace of the fault, where the fault plane has a dip of approximately sixty degrees, that this dip of the surface beds decreased very quickly to 40-35-30 and finally to the magnitude of 20 to 15 degrees and maintained this dip for several miles. This drilling disclosed the fact that the Saltville Fault was a bedding plane fault, the thrust being carried by the Honaker dolomite and that the MacCrady formation was below the thrust fault for this entire distance. A cross section of the Saltville Valley at the dip of the Saltville Fault, and the normal fault near the northwest side of the valley, brought out strikingly the fact that a downward displacement of the rocks on the southeast side of the normal fault would account for an upward drag of the Saltville fault plane,

resulting in the high dip of the Honaker dolomite which forms the hanging wall of the fault.

It is felt that wherever a thrust fault outcrop shows dips of sixty degrees or more, that this abnormally high dip can best be accounted for by the presence of a normal fault a few hundred feet north, or northwest, of the outcrop of the thrust fault, particularly if the dip of the rocks in the thrust fault block flatten out to approximately twenty degrees within several hundred feet of the fault trace.

This is the new concept of Appalachian Thrust Faults advanced by the author.

3. Concerning the Influence of Meg. B-8, an East-West Zone of Crustal Megashearing.

B. Ashton Keith; *Department of Geology, Institute of Sciences, Washington, D. C.*

This paper summarizes voluminous evidence indicating the presence of a long and comparatively narrow zone of moderate crustal shearing. In particular its trend is marked by numerous evidences of deep crustal penetrations that are roughly in-line across the southern parts of this and eight other states. Mathematical calculations on the possible distortional effects of the centrifugal force caused by Earth's rotation and on the forces of Coriolis calculated for the 37th parallel of latitude definitely indicate the probability of differential movements in the rocks, and with axial trends very nearly like many actually found in nature within this belt. More than two hundred indications of crustal penetration have been found including igneous plugs, necks, dikes and lava-flows, at least four crypto-volcanoes, more than seventy diatremes, two recognized laccoliths and more than one hundred reported igneous intrusions.

Using production figures from official sources, it is shown that the grand total production of mines within this zone exceeds \$100,000,000 per year for gold, silver, copper, lead and zinc only; while the total values for petroleum and natural gas produced each year vastly exceed that figure. An interesting comparison is made of the average annual productions per square mile with those of the rest of this United States, and with those of a similar belt next adjacent on the south, but with far fewer indications of crustal penetration or of disturbances in the strata.

4. The Stratigraphy of the Bradford Sandstone and Superjacent Marine Strata in Southwestern Virginia.

Lynn Glover; *Virginia Polytechnic Institute.*

A detailed study has been made of the succession of strata embracing the Devonian-Mississippian boundary in southwestern Virginia. The stratigraphic and faunal information obtained indicates the necessity of recognizing significant changes in age assignment and nomenclature of the units involved. Seven sections were measured in the belts of outcrop

extending from the vicinity of Blacksburg, Montgomery County, to Broadford, Smyth County, Virginia. Fossils were collected from all of these sections.

The Broadford sandstone at its type locality is not of Osagean age as Reger thought. Unfortunately the type section seems to be barren of fossils. By the use of stratigraphic position, and key beds, the Broadford sandstone has been located in all of the six sections measured to the northeast of Broadford, and in each a Coneango fauna consisting of representatives of the genera *Cyrtospirifer*, *Schuchertella*, *Mytilarca*, and others has been found. Generally the real Broadford sandstone in Virginia has been mapped as part of the "Chemung formation," and younger Mississippian units have been mistakenly identified as the Broadford sandstone.

Rusty weathering, flaggy, marine sandstones and shales overlie the Devonian Broadford sandstone, and are terminated by the Cloyd member of the Mississippian Price formation. This unit contains *Camarotoechia*, *Chonetes*, *Allorhynchus*, and *Pseudoxyrinx*. The succession is tentatively recognized as a separate formation, and on the basis of its early Mississippian fauna.

5. Silurian Formations of Southwest Virginia.

Ralph L. Miller and Leonard D. Harris; *U. S. Geological Survey*.
(Presented by Ralph L. Miller)

In Lee County and western Scott County, Virginia, the Silurian rocks have consistently been divided into three formations. These are in order upward the Clinch sandstone, the Clinton formation, and the Hancock dolomite (called Cayuga by some geologists). Although these formations are in general readily distinguishable from each other, their mapped and described contacts have not in the past been consistently interpreted. The Clinch sandstone contains a basal shale member that appears to be everywhere present along the Silurian belts of Poor Valley Ridge, Wallen Ridge, and Powell Mountain. The base of the Silurian and of the Clinch sandstone has commonly and erroneously been placed at the top of this shale member rather than at its base, where the prominent disconformity lies. The contact between Clinch sandstone and Clinton formation is also marked by a disconformity very close above which are found fossiliferous sandstone and red shale containing abundant *Geolospira hemispherica*. This contact also has tended to wander as described in stratigraphic sections and shown on geologic maps of Lee and Scott Counties. The Hancock dolomite of southwest and central Lee Counties grades northeastward and eastward into a more limy and sandy facies. The lithologic term dolomite as applied to the Hancock by Miller, Fuller, and Brosé is not applicable in Scott County or Wise County.

6. Evidence of Turbidity Currents in the Lynchburg Formation.

Edwin O. Gooch; *Virginia Geological Survey*.

Fragments of shale and other fine-grained sediments occur in massive,

coarse-grained beds of the Lynchburg formation in Madison, Culpeper, and Rappahannock counties, Virginia. These fragments, many of which show bedding and resemble the fine-grained beds of the Lynchburg and thus are probably intraformational in origin, are very irregular in size and shape. The edges of these fragments are, for the most part, sharp and angular and show little of the smoothness or roundness that would be expected as a result of stream transportation. However, well-rounded pebbles are associated with these fragments. This association, as well as the occurrence of the fragments and pebbles in otherwise well-graded sediments, seems incomparable—for sediments transported by streams and deposited under normal conditions of sedimentation.

In view of recent studies by Kuenen and Migliorini on turbidity currents as agents of transportation and deposition, and the characteristics of sediments thus formed, it is believed that the sediments under consideration were transported and deposited by such currents.

7. Mineralogical Studies of Sediments of the Nottoway River, Virginia.

Alden M. Pitard, Daniel E. Popovich, William V. Trollinger, and Henry D. Wagener; *Washington and Lee University*. (Presented by Alden M. Pitard.)

In a microscopic study of the heavy minerals of the Nottoway River, certain definite correlations were found to exist between the minerals in the samples and the parent rock forming the river bed. Biotite was derived from the Petersburg Granite, and garnet from the Red Oak Granite. The Aporhyolite formation contributed large quantities of epidote and hornblende. Zircon, muscovite, and rutile were all taken from the Wissahickon Granitized Gneiss formation. The samples used in this study were obtained and processed by the usual procedures employed in sedimentary petrography.

8. An Occurrence of Oolitic Chert in Rockbridge County, Virginia.

Perrin Walker; *University of Virginia*. (Introduced by R. S. Edmundson)

A blue-black, lenticular, oolitic chert occurs in a six inch sandstone bed lying between two beds of Conococheague dolomite, which outcrop on the first ridge south of Buffalo Creek along U. S. Route 11, approximately eleven miles south of Lexington, Virginia. The chert was formed from the precipitation of colloidal ferrous iron and silica; and, as colloidal matter coagulates in globular units, oolitic structure was formed. The oolites may be banded concentrically and contain either: (1) a black iron center; (2) a clear silica center, or (3) a quartz grain center. Geodic structures lie in the central section of lenses and show two distinct crystallization bands. They represent the last liquids of dehydration within the gel. Some parts of the main silica mass, geodes and oolites go to extinction under crossed nicols, showing crystalline quartz. A cyanide test was posi-

tive for ferrous iron only after 48 hours. This reaction time-lapse substantiates colloidal precipitation, although X-ray powder photographs with Cu radiation show crystal structure. Coloidal silica is known to convert to crystalline quartz at temperatures above 200° C, and the crystal structure appearing on X-ray photographs has been determined as alpha quartz (3.35; 4.26; 1.37).

9. Residual Sands and Erosion Surfaces of Western Virginia.

W. D. Lowry; *Virginia Polytechnic Institute.*

Residual quartz sand deposits, several of which are commercial, occur at a number of localities in western Virginia. The deposits were formed by intensive weathering of quartzitic sandstones ranging in age from early Cambrian to Mississippian. They are erosional remnants of formerly more extensive soil profiles and their preservation is related to their favorable location near drainage divides. The elevation of the deposits ranges from 925 feet to 3750 feet. The two highest deposits are on or near relatively stable major drainage divides which represent remnants of the surface produced by the Schooley erosion cycle—an extensive to middle Cretaceous time of the Fall Zone cycle. Most deposits are approximately 2400 in elevation and are on the slopes of divides. They represent remnants of an extensive soil profile developed during the Harrisonburg erosion cycle. This cycle of Virginia's Atlantic slope streams began in middle Cretaceous time and ended in Oligocene time. The approximately 1500-foot difference in elevation of the Schooley and Harrisburg surfaces in western Virginia is the result of differential uplift of the Appalachians with the Fall Line serving as a pivotal axis. The duration of the Harrisburg cycle is estimated by the amount of downward tilting of the marine sediments of the Coastal Plain. The ensuing Piedmont erosion cycle was terminated with the withdrawal of the Miocene sea which initiated the present cycle. The active erosion of the present cycle is in part due to an increase in the gradients of major streams resulting from eustatic lowering of sea level during Pleistocene time.

10. Mineralogical Studies of Sediments of the Smith River, Virginia.

G. M. Young, R. F. Bee, and J. R. Kean; *Washington and Lee University.* (Presented by G. M. Young.)

This is a paper written in conjunction with curricular activities at Washington and Lee for the purpose of studying the stream sediments for heavy mineral distribution of the Smith River drainage basin of Southwest Virginia. Further, the study includes investigation for correlation of the sands as to probable mineral derivation.

Heavy minerals found in Patrick, Henry, and Franklin counties were: Biotite, Diopside, Epidote, Hornblende, Illmenite and Magnetite, Kyanite, Muscovite, Rutile, Sillimanite, Staurolite, Titanite, Tourmaline, and Zir-

con. Hornblende, Illmenite and Magnetite were found as the most abundant, with Kyanite and Zircon generally common.

Only two good correlations were found. Titanite apparently is derived from the Garnetiferous Biotite Schist of the Wissahickon Schist. Sillimanite is probably derived from local conditions in the Wissahickon schist. All other minerals originate in Lynchburg Gneiss or Hornblende Gabbro Schist.

11. Lithologic Variations in the Upper One-third of the Beekmantown Formation along Cub Run Creek.

Robert M. Cordova and George S. Meadors; *University of Virginia*. (Presented by George S. Meadors.) (Introduced by R. S. Edmundson.)

This paper presents observations in the Beekmantown limestone and dolomite along Cub Run Creek, about five miles north of Shenandoah, Virginia, on U. S. Route 12.

The method of study is based on field observation, etching, staining, and petrographic thinsections.

In general, the upper third of the Beekmantown is a light grey to blue, slightly cherty, fine-grained limestone and magnesium limestone interbedded with dolomite. Three elliptical dolomite masses were noted and detailed work was done on the largest of these in order to draw conclusions as to origin. This largest dolomite mass contains several rectangular to square-shaped limestone blocks which are orientated at random and the largest being ten by twenty inches in size. The dolomite mass makes a very sharp contact with the surrounding limestone, and also contains an intraformational conglomerate with limestone pebbles having a range of one-fourth to three-fourths inches in size. Due to the fineness and the anhedral shape of the dolomite grains, the writers concluded that this mass had been chemically precipitated in a cave or tunnel. This precipitation proceeded slowly, gradually forming an ooze into which the limestone blocks fell. The occurrence of the intra-formational conglomerate around the lower periphery of the dolomite mass is indicative of movement causing the adjoining limestone to be torn away, forming a conglomerate.

12. Early Paleozoic Structure in Southwestern Virginia.

Wayne E. Moore; *Virginia Polytechnic Institute*.

Expanding stratigraphic studies in southwestern Virginia are revealing isopach, lithofacies, and unconformity patterns which indicate the existence of gentle warps that originated as early as the Canadian. Preliminary results suggest that biofacies also indicate the pressure of these early warps. Although the crests of the anticlinal warps appear to have shifted from time to time, definite areas remained structurally high throughout all, or much, of the Paleozoic.

An early Paleozoic anticlinal warp of the type described exists in the Washington-Russell County area of Virginia. The gentle nature and pattern of these warps appear to be similar to those existing in the Gulf Coastal Plain Province.

13. Mineralogical Studies of the Sediments of the Meherrin River.

J. L. Hinkle, E. K. Haight, J. C. Rich, and J. A. Sites; *Washington and Lee University*. (Presented by J. L. Hinkle.)

A total of sixteen samples of sand were collected from the Meherrin River starting near the source in Lunenburg County, Virginia, and continuing to a point near the North Carolina border. The methods used to separate the heavy minerals from the sand were the ones usually used in sedimentary Petrology. The twelve minerals that composed the first sample were found to be present in the remaining samples. This similarity of composition is no doubt due to the similarity of the Pre-Cambrian gneisses and granites from which the river derives its sediment.

14. Mineralogy of the Clay Fraction of Some Piedmont Soils.

James L. Eades; *Council of Highway Research and Investigation, University of Virginia*.

The -5 micron portion of several diversified soils were separated by sedimentation fractionation. The -5 micron portion was subdivided further into smaller particle sizes (-5 mic. to 2, -2 mic. to 1 mic., -1 mic. to .2 mic., and everything below -.2 mic.), in two of the soils for the purpose of trying to determine the portion best suited for x-ray analysis. Physical properties were evaluated on the original -40 sample. The -1 micron portion was analyzed for clay mineral identity by x-ray diffraction.

These data were collected to study the relationship of clay minerals to the parent material.

15. Paragenesis of Mineralization in the Climax Molybdenum Deposit, Colorado.

Charles E. Sears, Jr.; *Virginia Polytechnic Institute*.

The Climax molybdenum deposit is located at Climax high in the Front Range in northeastern Lake County, Colorado. The country rock in the mineralized area is the Idaho Springs formation and the Silver Plume granite which has intruded and partially assimilated the Idaho Springs formation; both are of Pre-Cambrian age. Tertiary dikes and sills ranging in composition from quartz porphyries to quartz monzonite porphyries intrude the older rock. Extensive hydrothermal alteration has altered the country rock resulting in silicification, argillization, sericitization, and topazization. The mineral sequence is pyrite, chalcopyrite, wolframite and cassiterite; molybdenite; wolframite and cassiterite, topaz; rhodochrosite, galena and spalerite. Monozite occurs along with the cassiterite and is especially abundant in high sericitized zones.

16. Geologic Section Across Western Floyd County, Virginia.

Richard V. Dietrich; *Virginia Polytechnic Institute.*

Floyd County is one of the three areas indicated on the Geologic Map of Virginia (1928) as "Undifferentiated pre-Cambrian rocks." This is a report of progress in the geologic mapping of the county.

Western Floyd County is in the highly dissected Blue Ridge Plateau. It is drained by tributaries of the New River.

Nearly all prominent S-planes in the rocks of western Floyd County have a northeast strike and a moderate southeastward dip. A generalized geologic section from the Pulaski County line on the north to the Patrick County line on the south, taken approximately perpendicular to the regional strike is:

Lower Cambrian quartzites and arenites
—(Mylonitized fault zone)—
Augen gneiss with intercalated phyllites and "pyroxenites"
Phyllite (locally graphite-bearing)
Gneissic muscovitic and biotitic quartzite with included metagabbros
Amphibolite
Gneissic graphitic-muscovitic quartzite

The following questions are considered: Are the Blue Ridge metamorphic rocks of pre-Cambrian age? Are these metamorphosed volcanics in the western Blue Ridge? What is the origin of the "pyroxenites"? Is the "Lovingston granodiorite" of igneous origin? Do the great apparent thicknesses of some of the units reflect isoclinal folding? Are some of the "thrust faults" unconformities? When did mineralization occur with respect to the tectonism?

17. Geology of the Iron Deposits at the Riverside Mine near Alvarado, Washington County, Virginia.

Byron N. Cooper and William E. Diggs; *Virginia Polytechnic Institute.* (Presented by William E. Diggs.)

The iron deposits at the old Riverside Mine near Alvarado, Washington County, Virginia, are typical of the so-called limestone magnetite deposits of the Appalachian Valley in Virginia and northeastern Tennessee. Most of the iron occurs in the form of sulphides, carbonates, and oxides which fill irregular interstices in a limestone-dolomite-chert breccia, a substantial part of which is believed to represent a sinkhole-filling in the upper 350 feet of the Knox dolomite. Following post-Canadian emergence and erosion, the sinkholes developed on the Knox were inundated by the fetid waters of the Liberty Hall sea. Iron chiefly in the form of marcasite was precipitated in the open spaces between the blocks composing the sink-

hole-filling. Possibly some of the iron was deposited as carbonate, but part of the iron carbonate minerals and probably all of the oxides, including magnetic hematite, were formed long after introduction of the iron in the sulphide form. Locally, there is a thin gossan cap of spongy limonite. The mineralization at the Riverside Mine is very localized. There are a number of geologically similar deposits within a few miles, but none is so well exposed. The "magnetite" that has been reported from these bodies is actually a magnetic variety of massive hematite.

18. Trilobites from the Lower Champlainian Formations in the Appalachian Valley.

Byron N. Cooper; *Virginia Polytechnic Institute*.

Forty-five species of lower Middle Ordovician trilobites, including six new genera and thirty new species, are described and illustrated from the extensive collections in the United States National Museum. Most of these species occur in beds whose age and correlation have been a matter of controversy for more than a decade. The stratigraphic evidence afforded by the trilobites lends strong support to regional stratigraphic interpretations of the lower Champlainian beds in the Appalachian Valley, which have been worked out by G. Arthur Cooper and the writer from detailed study of brachiopod faunas and from physical stratigraphic studies. The trilobites, like the brachiopods, are not so restricted in their facies distribution as are many groups of invertebrate fossils. Hence, they are very useful in establishing contemporaneity of dissimilar facies. In this paper only the more common trilobites are described. The principal purpose of this study is to make available for bio-stratigraphic use a number of trilobite species, most of which have been confused or misidentified previously.

19. Outline of the Geology of Poor Mountain, Roanoke and Floyd Counties, Virginia.

T. E. Shufflebarger; *Virginia Polytechnic Institute*.

The bedrock of Poor Mountain constitutes an allochthonous block in the Blue Ridge fault system and is composed of the three principal formations of the Chilhowee group. Rocks of the Unicoi formation, Hampton shale, and Erwin quartzite are discussed. A lava flow and associate diabasic rock in the Unicoi formation are assigned to basal Cambrian age and represent eruptive and source-vent materials respectively.

Intricate flexures and large drag folds are the result of low-angle faulting which has thrust basal Unicoi rocks over upon the Rome formation.

20. Subsurface Reconnaissance by the Electrical Resistivity Method.

John P. Meador; *Virginia Department of Highways*. (Presented by W. T. Parrott; *Virginia Department of Highways*.)

This paper deals with the experience of the Virginia Department of Highways's use of the electrical resistivity unit for sub-surface investigations. The theory of resistivity is briefly discussed with a case history of eight miles of new location which was mapped using the unit. It is concluded that the unit is most useful for location and design work over new locations for the purpose of classifying soil and rock excavation. A detailed knowledge of the geologic conditions in the area mapped is essential. It is desirable that several check holes be put down in the area for the purpose of correlation.

21. Some Current Activities and Projects of the State Geological Survey.

William M. McGill; *Virginia Geological Survey*.

A brief account of activities and projects of the Virginia Geological Survey during the current fiscal year (July 1, 1952-June 30, 1953), including projects of the State Survey and the United States Geological Survey. Listed are projects on which field work is in progress; projects on which field work has been completed and reports thereon in preparation; completed projects on which reports are now in process of being printed and projects on which reports are being edited and prepared for printing within the next few months; and ground-water investigations in progress, as cooperative projects between the State and Federal Surveys. New quadrangle topographic maps, issued since June 1952, and quadrangles in which work is in progress are also listed. The status of topographic mapping in Virginia is illustrated on a Progress Map.

FIELD TRIP — MAY 9, 1953

Sixteen cars and forty people left the V.M.I. parade grounds at 8:30 for the annual field trip of the Geology Section. Stop number one was on U. S. Route 60 at the basal conglomerate near the crest of the Blue Ridge. Stop number two was at Humphreys Gap where Unakite was examined. The next stop was on the Bunker Hill Trail near the Lynchburg Reservoir. Here Messrs. Charles Burford and Lewis Hite of Buena Vista located a deposit of allanite by means of Geiger counters. An occurrence of graphite was also examined. The party returned to Humphreys Gap and continued northward along the Blue Ridge Parkway. Stops were made at Boston Knob for lunch, at contact of Cambrian and Pre-Cambrian, and at a large dike enroute to the tin mine at Irish Creek. At this last stop the group examined the mill and dumps of the old mine and collected specimens of the many minerals available. Members of the group went their respective ways at 3:30. Much of the success of the trip was due to Ranger Raymond L. Ives and Naturalist William G. Lord of the U.S. National Park Service.

BUSINESS MEETING

At the close of the technical session, which had about sixty people in

attendance, the nominating committee presented the following slate of officers:

Chairman: Wayne E. Moore

Vice-chairman: William T. Harnsberger

Secretary: Marcellus H. Stow

Section Editor: W. D. Lowry.

There were no further nominations from the floor, and the candidates nominated by the committees were unanimously elected. Information concerning the field trip on Saturday was presented by Marcellus H. Stow.

MINUTES OF THE SECTION OF MEDICAL SCIENCES [9]

E. G. HUF, *Chairman*

D. H. R. GOURLEY, *Secretary*

WILLIAM BICKERS, *Section Editor (1953)*

FRIDAY, MAY 8 — 10:30 A. M. — ROOM 442, MALLORY HALL

1. Effect of Insulin on the Oxygen Consumption of Intact Skeletal Muscle *in vitro*.

D. R. H. Gourley; *Department of Pharmacology, University of Virginia Medical School.*

Two effects of insulin have been demonstrated in a single tissue, the intact isolated *extensor digitorum longus* muscle of the rat. The first effect of insulin is to stimulate the rate of oxygen consumption but this is not observed if a substrate such as lactate, pyruvate or glucose is also present. The second effect of insulin is to increase the rate of glucose utilization and glycogen deposition in the muscle. This effect is only observed in the presence of glucose. Thus the insulin effect on the oxygen consumption of the extensor muscle and the effect on the glycogen deposition occur under different experimental conditions. It is therefore tentatively concluded that the two effects are independent phenomena.

2. The Influence of Low Protein Diet on the Distribution of Amino Acid Oxidases in Rats.

C. Hoch-Ligeti; *Department of Pathology, University of Virginia Medical School.*

In connection with experiments on the influence of nutrition on the development of hepatic tumors, the effect of nutritional factors on the amino acid oxidases was studied.

Wistar rats were divided into three groups: (a) on low protein diet, (b) low protein diet with the addition of alpha estradiol (5γ daily), (c) on a full diet. In the rat, amino acid oxidases are present in appreciable quantities only in livers and in kidneys. The d. amino acid oxidase was determined by measuring the oxygen uptake of liver or kidney homogenates in the presence of d. l. alanine or d. aspartic acid as substrate by the Warburg technique.

In the livers of both groups of rats on low protein diet, the amino acid oxidase levels dropped to half of that of rats on a full diet. The levels of the kidneys were the same in all three groups. In view of the role of the liver in protein metabolism, the finding that, on reduction

of dietary proteins, a decrease of the amino acid oxidase occurred in livers only, might be of physiological importance.

3. Autonomic Responses from the Cortex of the Dog.

H. G. Langford, M. Bernhaut, and E. C. Hoff; *Department of Neurological Science, Medical College of Virginia.*

While the autonomic responses of the cortex of the cat have been well studied, the references to the dog are scattered and conflicting. The first series of dogs were done using nembutal anesthesia, 25 mgm./Kgm. Trachotomy was done, the animal was maintained on positive pressure breathing, the femoral artery was cannulated, and craniotomy was performed. Blood pressure was recorded using a sylphon bellows manometer. Curare was given as needed to block skeletal movement. The cortex was stimulated with bipolar electrodes.

This series of animals gave either no response or depressor responses from the anterior and posterior sigmoid gyri. Towards the rostral end of the cortex pressor responses were obtained which were of 20-30 mm.Hg amplitude. These were obtained 6-7 hours after the experiment started, as this region was reached late in the experiment.

As these responses were different from those obtained in the cat using ether anesthesia, the next series of experiments was done using ether and curare anesthesia.

Here the great majority of these responses were pressor, from the posterior sigmoid to the tip of the frontal cortex. They differed from the cat in frequently lasting for 90-120 seconds, instead of 20 seconds, in the cat.

4. The Role of Epinephrine in Ether Hyperglycemia.

D. T. Watts; *Department of Pharmacology, University of Virginia Medical School.*

Much indirect evidence has been published indicating that hyperglycemia characteristic of ether anesthesia is due to the release of epinephrine and mobilization of liver glycogen. Assay methods have not been sufficiently sensitive to demonstrate increases of epinephrine in the general circulation during ether anesthesia. In the present experiments the extremely sensitive bioassay method of Gaddum and Lembeck (Brit. J. Pharm. 4:401, 1949) based on the inhibition of the isolated rat uterus by epinephrine has been used to estimate the epinephrine content of rabbit plasma before and during ether anesthesia. Blood samples were obtained by cardiac puncture as follows: (a) before anesthesia, (b) at the end of induction of surgical anesthesia, (c) after 30 minutes surgical anesthesia. The epinephrine content of plasma from these samples was found to be (millimicrograms/cc. plasma \pm standard error for 13 rabbits) 3.7 ± 1.1 , 6.8 ± 1.6 and 11.6 ± 2.9 respectively. These increases in the epinephrine content of the circulating blood over the preanesthetic level are

statistically significant. Current experiments indicate that acute hypertensive episodes in the dog during ether anesthesia are accompanied by marked increase in the epinephrine content of the circulating blood.

5. Synthesis and Metabolism of N¹⁵-labeled Ethanolamine.

Lynn D. Abbott, Jr. and Jack D. Klingman; *Department of Biochemistry, Medical College of Virginia.*

Information regarding the rate and extent of conversion of ethanolamine nitrogen to urea is not available. Data on the nitrogenous metabolism of ethanolamine may aid in understanding its intermediary metabolism. This problem can be studied with isotopically labeled ethanolamine.

We have developed an improved synthesis of ethanolamine for the purpose of preparing the N¹⁵-labeled compound. N¹⁵-Potassium phthalimide was condensed with *beta*-chloroethylacetate in dimethylformamide. The resulting substituted phthalimide was isolated and hydrolysed by boiling with 20% HCl. N¹⁵-Ethanolamine hydrochloride was isolated in good yield.

The excretion of N¹⁵ in urinary nitrogen and urea, and in fecal nitrogen, was determined after oral administration of single doses of N¹⁵-labeled ethanolamine hydrochloride to rabbits. The compound contained 32 atom % N¹⁵ and was given in an amount containing 2 meq. N¹⁵. The first day's urine was collected in 2 periods, the first 6 hours after administration and the following 18 hours. Excretion in 24 hour periods was then followed for 2 weeks. Urine was analysed for nitrogen, urea, ammonia and creatinine. N¹⁵ analyses were made on total nitrogen and on urea isolated as the xanthidrol derivative. Fecal nitrogen and N¹⁵ were determined daily for the first week and then in 4 day periods. The data indicated a very rapid and extensive conversion of ethanolamine nitrogen to urea. On a comparatively high nitrogen diet as much as 40% of the administered N¹⁵ was excreted in this form in the first day, and with a rabbit on a lower nitrogen intake, 34%. The excretion was more rapid and greater than we have found after administration of a comparable dose of N¹⁵-glycine under similar circumstances. This may be interpreted as evidence of early deamination and conversion to urea without intermediate glycine formation.

6. The Ionization Constants of Thyroxine and Related Compounds.

Chalmers L. Gemmill; *Department of Pharmacology, University of Virginia Medical School.*

By using long cells in the Beckman Spectrophotometer, absorption spectra in the ultraviolet of solutions of 2.1×10^{-6} M of DL-thyroxine, 3,5-diiodo-L-tyrosine, DL-thyronine, 3,5-diiodo-DL-thyronine, and 3',3,5-tri-iodo-L-thyronine were studied in acid, base and at an intermediate pH. From these determinations, the apparent ionization constants (pK') of the hydroxyl group in these compounds were calculated. The pK' of

this group in thyroxine (6.71) approximated the pK' of diiodotyrosine (6.56), the pK' of triiodothyronine (8.39) was comparable to that of monoiodotyrosine (8.2) while the pK' of thyronine (10.28) and of 3,5-diiodothyronine (10.17) were comparable to the pK' of tyrosine (10.05). The value of the pK' of monoiodotyrosine was obtained from Herriott (J. Gen. Physiol., 31, 19, (1947-48) and for tyrosine from Crammer and Neuberger (B. J., 37, 302, 1943). In this work, the maxima of the absorption spectra of these compounds was obtained in acid and base. It was found that the two iodines in the 3' and 5' positions contribute greatly to the intense absorption for thyroxine at 325 mu., while the presence of one iodine in the 3' position causes the absorption of triiodothyronine to occupy an intermediate position between thyronine and thyroxine in the acid as well as in the basic solutions.

7. Effects of ATP Complexes on P³² Uptake by Rabbit Erythrocytes.

H. Jonas; *Department of Pharmacology, University of Virginia Medical School.*

Previous investigations of this department have demonstrated intracellular equilibria of human erythrocytes between orthophosphate, ATP, and phosphorylated metabolites. These internal concentrations were also in equilibrium with extracellular orthophosphate, which surpassed intracellular phosphate forms, indicating phosphate adsorption on the cell membrane. This report gives further evidence that added orthophosphate and ATP are taken up by rabbit erythrocytes by adsorption and subsequent absorption. Rabbit blood was obtained by cardiac puncture with heparin and then incubated for 3 hrs. with concentration series of P³², ATP, and Mg⁺⁺. The blood was centrifuged after chilling, and P³² activity measured from plasma aliquots. The cells removed P³² from the plasma from extracellular concentrations of less than 10⁻⁷ moles P³²/ml red cells (according to a Freundlich adsorption isotherm). Further P³² uptake was by absorption, which reached saturation at about 5 x 10⁻⁵ moles P³²/ml red cells. Higher concentrations caused hemolysis. Spot checks on the effects of ATP on P³² uptake were inconclusive. But additions of various amounts of Mg⁺⁺ to 10⁻⁸ moles of P³² and of ATP/ml red cells showed a strong reduction of P³² uptake at equimolarity. Inhibition could be removed by doubling the phosphate supply. Apparently ATP and Mg combine to form a surface complex in competition with phosphate. Addition of various amounts of Mg⁺⁺ to 10⁻⁹ moles P³²/ml erythrocytes in the presence of 10⁻¹⁷ moles ATP/ml cells demonstrated some decrease of phosphate uptake at equimolarity of Mg⁺⁺ and phosphate. Magnesium charges may be visualized to compete partially with positive surfaces of -NH₃⁺ groups and to reduce the molarity of orthophosphate ions.

8. Effect of the Intravenous Administration of Paritol-C' on the Serum Lipids of Hypercholesterolemic Rabbits.

J. C. Forbes and O. M. Petterson; *Department of Biochemistry, Medical College of Virginia.*

Previous work from our laboratory showed that rabbits fed a 0.5 per cent cholesterol diet developed not only a state of hypercholesterolemia, but also most of the cholesterol was in a state from which it could be extracted from lyophilized serum by cold chloroform. This is in contradistinction to the results of a similar extraction of lyophilized serum from normal rabbits. In the latter only a small percentage of the total cholesterol is thus extracted while the extraction is usually over 90 per cent in the former. It has now been found that the intravenous injection of 5-10 mg. of the heparinoid, Paritol-C, per pound of body weight into such hypercholesterolemic rabbits caused a marked drop in the various cholesterol fractions. The percentage drop in the fraction which is extracted by cold chloroform in a 3-hour period — the "readily extractable" cholesterol — was usually greater than the drop in total cholesterol. The difference was especially pronounced when the total serum cholesterol had dropped to 700 mg. per cent or lower. The changes in the serum phospholipid and neutral fat content closely paralleled those of total cholesterol. Intravenous administration of Dicumarol was without effect on any of the fractions studied.

9. A Histochemical Study of the Lipids of the Corpus Luteum of Pregnancy in the Water Snake, *Natrix sipedon sipedon*.

Douglas E. Bragdon; *Department of Anatomy, University of Virginia Medical School.*

Progesterone is present in the plasma of non-pregnant female water snakes. During pregnancy it is present in increased amounts and from the small series of animals studied, appears to increase during pregnancy, reaching its highest titer at full term.

Frozen sections of formalin fixed corpora lutea from different stages of pregnancy were subjected to Sudan staining for total lipids, the Schiff plasmal reaction, the Schultz test for cholesterol and examination for birefringence under the polarizing microscope.

In early pregnancy the cytoplasm of the granulosal cells contains small to medium sized lipid droplets which are sudanophilic, Schiff and Schultz positive, and acetone soluble. In chilled sections, numerous small birefringent crystals can be seen. As pregnancy advances, the sudanophilia and the amount of Schiff and Schultz positive material decreases and the birefringent crystals become fewer and coarser.

The lipids of corpora lutea in the second trimester were unresponsive to mammalian LH and prolactin given on alternate days for three doses, the corpora lutea being excised on the second day after the last injection. Although the gradual decrease in lipids may indicate a continued utilization of previously stored cholesterol for progesterone production, the decrease in granulosal cell size and nuclear volume such as occur here are generally indications of lessened activity.

10. Effect of Repeated Administration of Alcohol on Guinea Pigs on a Scorbuto-Genic Diet.

J. C. Forbes and G. M. Duncan; *Department of Biochemistry, Medical College of Virginia, and the Division of Alcohol Studies and Rehabilitation, Department of Health, Richmond.*

Our former work has shown that a single acute intoxication of rats and guinea pigs caused a marked reduction in the concentration of cholesterol and ascorbic acid in the adrenal glands. We wished to determine whether repeated intoxication would increase the rate of depletion of cholesterol and ascorbic acid in the adrenal of guinea pigs on a scorbuto-genic diet and thus accelerate the development of scurvy. Intraperitoneal injection of 4 gm. of alcohol per kg. of body weight as a 10 per cent solution on alternate days 3 times each week did not accelerate the rate of development of the scorbutic condition over pair-fed controls receiving glucose only. After 6 weeks, 7 of 15 receiving alcohol were dead, 1 was moribund; in the control group 6 of 18 were dead and 5 moribund. Those still living at that time were sacrificed 72 hours after the last injection, and no difference in the concentration of the adrenal cholesterol was found between the test and control groups although the values were lower than in normal animals. Under similar experimental conditions 0.5 mg. ascorbic acid per 100 gm. of body weight added to the injected solutions, maintained the cholesterol of both groups at normal concentration and the ascorbic acid at a low but measurable amount. Liver ascorbic acid was lower in 24 hours, but higher in 48 hours after alcohol intoxication than in corresponding glucose controls. This difference between test and control animals tended to disappear 72 hours after the stress, and may indicate no greater loss from the body because of the adrenal stimulation.

11. The Possible Role of Psychological Factors in Causalgia.

M. G. Mitts; *Medical College of Virginia.*

Causalgia is a peripheral nerve injury syndrome with an unusual clinical pattern. Among the many manifestations of this disorder include intense burning pain, dry skin, hyperthermia, wasted muscles, and in some cases function loss in the affected limbs.

Causalgia occurs mainly in the hand and foot, and follows injury to large nerves, arterial or venous occlusions, fractures, sprains, infected wounds, and other minor injuries. There is considerable perplexity regarding the rather devastating symptoms following such a restricted injury.

The physiological mechanism is not understood, but it is known that the injured region in causalgia gives unusual potentials. This information along with the data on facilitation may be a possible basis for an explanation, but it leaves unexplained the dramatic effects which psychological changes bring about. While neuro-surgical methods sometimes alleviate the symptoms, there is no therapy known which can be considered a satisfactory remedy. There is scattered and fragmentary evidence to suggest

psychological factors may be important not only in the etiology, but in the termination of the disorder.

It is suggested that serious study should be given to possible use of psychotherapy in this syndrome.

12. Potentials from Pancreatic Acini.

S. Solomon; *Department of Physiology, Medical College of Virginia.*

A method has been described, which it is felt, allows for direct measurement of mouse pancreatic acinar cell electrical potentials *in vivo*. It consists essentially of using fine microelectrodes for a lead and measuring directly transmembrane potentials. Although some evidence can be presented to show that the electrode enters the cell, explicit proof is still lacking.

It has been found that the inside of the acinus is negative to the outside, with fed animals having lower measured values than sixteen hours starved animals. The range of mean values runs from 40 to 120 millivolts. In the resting state the potential is maintained for periods longer than three hours. It is depressed by .001 M iodoacetate and seems to be partly inhibited by .001 M NaCN.

BUSINESS MEETING

The following officers were elected for the Section of Medical Sciences for 1953-1954:

Chairman: D. H. R. Gourley

Secretary: Sidney Solomon

Section Editor: Ebbe Hoff

MINUTES OF THE SECTION OF PSYCHOLOGY [10]

S. B. WILLIAMS, *Chairman*

L. S. REID, *Secretary-Treasurer*

W. M. HINTON, *Executive Committeeman*

R. H. HENNEMAN, *Section Editor (1954)*

FRIDAY, MAY 8 - 9:00 A.M. - ROOM 359, MALLORY HALL

1. The Relative Effectiveness of Auditory and Visual Messages under Conditions of Noise.

James G. Holland; *University of Virginia.*

Two experiments were reported extending the findings of a series of studies which indicate that a distracting task interferes more with visual than with auditory message reception. The present study found that the differential influence of distraction extends also to the reception of distorted messages. It was further demonstrated that one previous presentation of a set of messages in non-distorted form enhances intelligibility under the dual conditions of distorted presentation and distracting task. However, no evidence was found to indicate that the introduction of familiarity affects reception through one sense channel to a greater extent than another.

It was concluded that neither message familiarity nor message distortion at the time of presentation removes the relative superiority of auditory presentation which occurs when subjects are engaged in a highly distracting task.

2. The Course of Cutaneous Adaptation to Audio-Frequency Currents.

Andrew W. Gottschall, Jr.; *University of Virginia.*

The results of preliminary control explorations indicate that the variables of stimulus intensity, body locus, electrode type and size, and the distance between electrodes are critical to the production of experience of cutaneous vibration.

The advantages of the intensity comparison method, as opposed to the threshold method for the study of the course of adaptation are discussed. Results of an additional control experiment indicate that adaptation effects are restricted to the ipsi-lateral side. Therefore, contralateral comparisons will be made in the study of the course of adaptation, as a non-affected area is required for the comparison stimulus.

3. Stability of Color Preference.

Walter A. Woods; *Richmond Professional Institute.*

Color preference studies, conducted over a period of many years, have revealed rather inconsistent results. Some investigators have doubted the value of such studies, since a lack of stability is suggested in results.

The present study investigates three hypotheses concerning stability of color preference.

(1) Preference for colors expressed by a selected group of observers are stable over a period of three months.

(2) Preference for colors is influenced by the particular choices offered to the observer group.

(3) Differences in color preferences may be demonstrated between stratified samples of observers.

Munsell system notated color samples were submitted for judgement to a number of different normal and psychotic groups. Results are discussed and variations and significance of date noted. Typical color preferences are discussed with reference to previous studies. Conclusions arrived at are:

(1) Color preferences tend to remain stable over a period of six months.

(2) Color preference is a function of choice of colors offered.

(3) Difference in color preferences exist between typical consumer groups, sophisticated consumers, "bizarre" consumers, psychotic females and psychotic males.

4. Non-Reinforced Training in the T-Maze.

Melvin Freitag; *University of Virginia.*

This study was an attempt to obtain latent learning in the absence of any primary reinforcer during training. The 24 experimental rats were given 26 unrewarded trials in a T-maze having a left black and a right white goal-box. Twelve control animals received equal training in an all gray T-maze. Half of the experimental and all of the control animals were given rewarded post-training trials in a straight alley apparatus where they received food in the goal-box corresponding to the brightness cue of their least preferred side during training. These discrimination trials continued until a learning criterion of 7 out of 8 correct choices was reached. Each animal in the remaining half of the experimental group received the same number of reinforcements as their matched running mate in the other experimental group in a straight grey runway with the least preferred goal-box attached. All animals were then tested in the original T-maze. Test trials were continued at 24-hour intervals until a learning criterion of 7 out of 8 correct choices was reached. There was no significant difference

between groups on the choices made on the first test trial or in the number of trials to reach the learning criterion in the test phase.

5. An Experimental Test of the Estes Versus the Bush and Mostellar Theories of Learning.

Beth Forester and Burton R. Wolin; *College of William and Mary.*

This experiment was designed to test two mathematical theories of learning, Estes versus Bush and Mostellar, in an human conditioning situation. The independent variables included the percentage of reinforcement, the amount of work involved and the position of the telegraph key to which the subjects were being conditioned. Of these, percentage of reinforcement had the greatest effect. It was found that the interaction of work and reinforcement had a significant effect upon the speed of conditioning. The effect of work alone was obscured by the male-female variable, which was not counterbalanced. It seems that work affected the speed of females but not of males. It is suggested that another experiment be designed in which all subjects are of the same sex.

6. The Use of Continuous Addition Technique in Psychological Diagnosis.

Vytautas J. Bieliauskas; *Richmond Professional Institute.*

The technique of continuous addition was designed by E. Kraepelin around 50 years ago for psychiatric purposes. R. Pauli has improved, standardized and established its value for examination of normal people, especially for diagnostic survey of personality.

The Pauli version of the technique, as we have it now, is still based upon the Kraepelin principle of continuous adding of digits. The addition takes one hour which is divided into 20 intervals (three minutes each). During testing, observations are carefully registered and an inquiry at the end supplies the introspective data. The interpretation of the whole test consists of two parts: statistical and diagnostic. An apparatus and other facilities simplify the statistical work; the diagnostic part uses standardized charts elaborated by R. Pauli. This author has done a research with 30 college students, and he presents statistical and diagnostic results achieved with this experiment.

Conclusions: The technique offers great possibilities for precise psychological diagnosis, and it has the advantage over many diagnostic tests in that it can be administered to bigger groups at a time; however, elaboration and interpretation are difficult and time consuming. A shorter version of this technique is submitted by the author. A comparison of both versions shows that the "new version" limits the diagnostic value of the test and gives less possibilities for elaboration of an overall psychological opinion, although it is valuable for fast appraisal of certain single per-

sonality traits. Since the technique allows a graphic description of the course of performance, its value for industrial psychology is obvious.

7. Serial Effects as a Function of Inter-stimulus Interval.

Willard F. Day; *University of Virginia*.

8. The Development of Syllogistic Reasoning in Children Five through Eleven Years of Age.

Charles A. Peachee, Jr.; *Central State Hospital*.

In this investigation the two premises of ten simple, valid categorical syllogisms were presented to 140 school children (individually tested) of average intelligence and between the ages of five and twelve. The resulting conclusions were scored according to their degree of accuracy and quality, a total score being given for each child, and these scores being quantitatively and qualitatively analyzed in respect to age and sex differences. Syllogistic reasoning was found to increase gradually with age, reaching a near peak at the 10-11 age level. A highly significant spurt in this ability was discovered at the 7-8 age level. No statistically significant sex differences were found. The Similarities Test of the Wechsler Intelligence Scale for Children was administered along with the Syllogisms Test, since the former is regarded as a test of reasoning, and the two tests correlated .67, suggesting, but by no means proving, that they are measuring a similar function.

The results were compared with the findings of Piaget, who studied French children's logicality of thought in the 1920's, and Bieliauskas, who investigated German children's syllogistic reasoning ability in 1942. These results are considered to have important implications for the fields of education and child guidance in general.

9. Tactual Apparent Movement.

Raymond C. Bice; *University of Virginia*.

Movement illusions have been of considerable importance in the history of experimental psychology. Early workers demonstrated that tactual apparent movement could be produced by successively stimulating adjacent areas of skin with non-vibrating stimulators, and that the illusions follow the laws of Korte. Hulin noted a vagueness about the perceived movement, pointing out that even under optional conditions the illusion is not always perceived.

Recent work at the Virginia laboratory has shown that clear illusions of movement may be obtained by use of vibrating stimulators. Low frequencies (below 100 cycles per second) give more diffuse sensations than do the higher frequencies. Further investigations are under way attempting to utilize the vibratactile illusion of movement for purposes of conveying information to a human subject.

10. Sweetness and Food Consumption.

William Wagman; *College of William and Mary.*

Three equated groups of white rats were fed:

1. a normal diet of powdered Purina dog chow
2. a normal diet with .1% saccharine added; and
3. a normal diet with 1% saccharine added.

The groups were rotated systematically on the three diets so that each group ate all three diets in different but balanced orders.

The amount of food eaten daily was approximately the same for all diets. Hence it is argued that sweetness alone does not normally cause increased food consumption, although studies by other investigators have indicated that sweetness does increase water consumption.

11. A Study of the Voice as Related to Personality Traits.

Cora Lynn Chaffee; *Richmond Professional Institute.*

This study was undertaken out of an interest in voice as a form of expressive movement. From various studies regarding the voice this investigator formulated a table of voice qualities and their possible meanings as to the personality of a person.

The voices of twenty subjects, five female and five male college students and five female and five male inmates of Virginia state penal institutions were recorded. Each subject read the same two selections and was asked to talk briefly spontaneously. Immediately following the making of the recording and the obtaining of background information, each person was given a Rorschach. These voices were later judged by nine psychology students according to the formulated chart. The judgments by the chart were then compared with the Rorschach findings.

There was positive statistical evidence that the overall impression regarding a given person gained from the voice and from the Rorschach was in agreement. However, the judging of specific personality traits from specific voice qualities was not substantiated.

12. Physical Dimensions Related to the Perception of Mechanical Vibration.

Carl E. Sherrick, Jr.; *University of Virginia.*

Consideration is given to some properties of the skin and underlying tissues which may contribute to the variation of sensitivity of the human observer with frequency of mechanical vibration. From the investigations of Geldard it is assumed that dense clusters of receptors sensitive to vibration do not respond selectively to various frequencies of vibration. The skin is considered a mechanical system possessing the fundamental

properties of mass, elasticity, and friction, and from these assumptions the U-shaped sensitivity curve for vibration usually obtained is explained as being a result of resonance of the skin tissues.

It is predicted that if the skin acts as described, then (a) skin conduction of vibratory disturbance should be greater at the frequency of maximal sensitivity, and (b) the mechanical impedance of the skin should be a minimum at the frequency of maximal sensitivity. Experiments were carried out to determine the validity of these hypotheses, and the results appear to confirm the hypotheses. It is suggested that future research should attempt to quantify these relations to determine the relative contributions of skin and bony tissue and of receptors and nerves.

13. A Study of Anxiety in the Minnesota Multiphasic Personality Inventory.

William E. Cook; *Richmond Professional Institute*.

Although many recent studies have involved the Iowa Test of Manifest Anxiety, no studies have yet related anxiety as measured by this test to the variables measured by the Minnesota Multiphasic Personality Inventory (MMPI). This study is concerned with these relationships. A key was constructed from the Iowa anxiety test which could be utilized within the MMPI. Overlap of this key with commonly-used MMPI keys is presented and discussed. The MMPI was administered to the 127 students in a general psychology class at the University of North Dakota. Answer sheets were scored for all commonly-used scales of the MMPI and for the anxiety key. Zero order correlations of each scale with anxiety for this group of subjects is presented and discussed. Mean profile scores and variabilities for anxious and non-anxious groups are presented and discussed. The relationship between anxiety as measured by the Iowa Test of Manifest Anxiety and anxiety as measured by the Welch Anxiety Index is determined and discussed. Other relevant studies are discussed in relation to these findings.

14. A New Short-cut Method of Psychotherapy for Psychoses.

John A. Blake; *Central State Hospital*.

The method of psychotherapy for psychoses herein outlined has been under experimentation and in actual use by the author in a mental hospital situation since September 1951. Although occasionally incorporating a few recognized special techniques of the "directive" method as variants, it claims to be generally a new, distinctive procedure. This claim is based upon the inherent characteristics of the following aspects: Scope of application, limitations to effectiveness, rationale of the method, general nature of the "Illumination" method, specific techniques, and desirable follow-up procedures.

BUSINESS MEETING

The business meeting was opened by the Chairman, Stanley B. Williams, at 2:00 P.M. He reported briefly on his activities for the year and appointed a nominating committee consisting of Miss Davis, Miss Shuey, and Mr. Finger (Chairman).

Mr. Finger, in the absence of the Secretary, reported a membership of 82 and pointed out the steady decline in the number of student affiliates associated with the section. He also read the Treasurer's report which recorded receipts of \$234.50 and disbursements of \$228.00, leaving \$6.50 to be disbursed. Of the disbursements, \$198.00 went to the Academy treasury and \$30.00 to the Conference of State Psychological Association.

Mr. Hinton, delegate to the Conference of State Psychological Associations, reported that the Conference favors accrediting legislation at the State level whenever it is needed to protect the public interest, and that the Conference when requested, will support the efforts of any State association which decides to sponsor legislation. Mr. Horlick moved that the section go on record as favoring the Conference's position. Mr. Horlick's resolution was passed.

The report of the Executive Committee was presented by the Chairman, Mr. Williams.

Following this report there was a lengthy discussion on the possible reorganization of the section. It was suggested that psychologists in various regions of the State might organize to hold local meetings, and Mr. Horlick moved that the Executive Committee be instructed to consider the feasibility of renaming the section the Virginia Psychological Association, an affiliate of the Virginia Academy of Science. This resolution was understood to include investigation of the legal requirements regarding the certification law, and consultation with the Academy. The motion was passed.

The report of the nominating committee was presented and the following persons were elected officers for the coming year:

President: Stanley B. Williams

Secretary-treasurer: Hannah S. Davis

Executive Committeeman: Reuben S. Horlick

Business meeting adjourned at 3:30 P.M.

MINUTES OF THE SECTION OF SCIENCE TEACHERS [11]

THOMAS H. CHRISTIE, *Chairman*

CAROLINE GAMBRILL, *Chairman-Elect*

MARTHA W. DUKE, *Secretary*

L. W. JARMAN, *Section Editor (1954)*

FRIDAY, MAY 8, 1953 — 9:00 A.M. — ROOM 252, MALLORY HALL

1. Embedding Biological Specimens in Plastics.

Howard H. Edgerton; *Carolina Biological Supply Company.*

- A. Plastic embedding can serve as a motivation for participation in the total laboratory experience.
- B. It can provide for concomitant learning for the student.
- C. Plastic embedding serves the science museum with mounted specimens.
- D. It makes an interesting hobby for the amateur collector who wishes to display his collection permanently.

Amber is a natural resin; plastic is a synthetic one. It was amber which inspired the chemist to adapt plastic to biological embedding. Plastic comes in the form of a heavy syrup and will gel to a rubbery mass with the addition of a catalyst. After it has gelled it is cured in a temperature of 120-140 degrees F., which results in a glass-like hardness.

The plastic technique then is a two-step process — gelling and curing.

Specimens may be mounted in one of three ways — transparent, wet-opaque, or dry-opaque.

First of all specimens have to be prepared — 70% alcohol or 10% formalin.

- 1. Transparent — Stain, dehydrate, soak in uncat. plastic, embed.
- 2. Wet-opaque — Air dry, embed.
- 3. Dry-opaque — Wet in plastic and embed.

Holds may be any smooth surfaced containers which adequately accommodate the specimens.

The embedding procedure goes like this:

- 1. Measure the thickness of the specimen.
- 2. Estimate the quantity of plastic which will give $\frac{1}{4}$ " in a base layer and $\frac{1}{4}$ " above the specimen in the chosen mold.

3. Estimate the total thickness of the mount and look up proper catalyst ratio of the catalyst table.
 4. Catalyze and pour a base layer of plastic and cool.
 5. Catalyze and pour a second layer and cool.
 6. Cover with wax paper and cure.
 7. Finish mount with sand paper to produce a smooth surface, and polish with buffering compound.
2. Preparation for College Chemistry.

William G. Guy; *William and Mary College*.

We need a closer relationship between the colleges and secondary schools. Three problems present themselves:

1. Does the high school do college work?
2. Does the college do high school work?
3. Do we ignore each other?

In the high school we have two types of students, those entering college and the student taking his only course in chemistry. How can we challenge the upper tenth and still make the work valuable to the non-college type? The unit system should provide an answer, here we can insert more difficult material to be worked on after the basic work is done. In every class we should make the historical approach first, give the students an appreciation of the past, then we can develop methods, observations, and arrive at principles.

3. Atomic Energy in High School Science Courses.

Captain C. E. Savage; *Augusta Military Academy*.

1. Integration of Physics and Chemistry Students
 - a. Placement and importance of study in a high school course.
 - b. Alternate days — Atomic energy from a chemistry standpoint, and then from a physics standpoint presented.
2. Introduction and Stimulation of Interest
 - a. Atomic bomb records — RCA Victor set — Bob Hope.
 - b. Presentation by comic books — Dagwood Splits the Atom
3. Laboratory Techniques
 - a. Balancing equations
 - b. Use of workbook
 - c. Introduction of Geiger Counter
4. Geiger Counter Experiments
 - a. Field trips to collect material which may be radioactive.

- b. Laboratory experiments with known radioactive materials.
 - 1. Effect of Lead, Aluminum and Cardboard as absorbers.
 - 2. Distance of effectiveness of each.

5. Presentation of A.E.C. Tape-Recorded Story of Atomic Energy.

6. Testing Program Used

- a. Quiz on atom and hydrogen bomb records.
- b. Quiz prepared by A. E. C.

7. Reading Materials for Outside Study

- a. Various sources — books on atomic energy and on splitting the atom.

8. Summary of Importance in the course and Reference to Civilian Defense.

9. Demonstration of Materials Used at A. M. A. (throughout the speech).

3. Use Techniques in Elementary Science.

John C. Wells; *Madison College*.

Six student teachers from Madison College presented a demonstration of science topics that could be taught in the elementary grades. Simple yet pertinent equipment was used to emphasize the principles in lighting the home, using the telephone and radio. All equipment could be assembled and put together by the more advanced students in the elementary grades.

Paul Desper, a student from Wilson Memorial High School, Fishersville, read his paper on "Measurement", which was his project in the Science Talent Search of 1952-53.

BUSINESS MEETING

The meeting was called to order by the chairman. The nominating committee presented the following slate:

Chairman-elect: G. L. Thomasson

Secretary: Martha W. Duke

As there were no nominations from the floor, these officers were declared elected.

Forty members attended the meetings of the section.

MINUTES OF THE SECTION OF STATISTICS [12]

A. M. MYSTER, *Chairman*

G. W. SUTER, *Vice-chairman*

C. Y. KRAMER, *Secretary*

W. A. HENDRICKS, *Section Editor (1954)*

FRIDAY, MAY 8 — 10:00 A. M. — ROOM 237, MALLORY HALL

1. On the Analysis of Variance of a Multiway Classification with Unequal Sub-Class Numbers.

Clyde Y. Kramer and David B. Duncan; *Virginia Polytechnic Institute*.

This paper reviews important current methods on the analysis of variance of a multiway classification with unequal sub-class numbers, presenting them from a unified point of view and also proposes a new method which has special advantages for particular situations.

For cases in which no interaction is present, the most efficient procedure is the method of fitting constants. The method of weighted squares of means is much simpler to apply but would generally sacrifice too much efficiency. The virtue of the new method is that it is equally simple for such cases and is more efficient than the method of weighted squares of means.

There are situations in which this would not be true and in which case the method of weighed squares of means should be used. A quick test for recognizing situations of this type is provided.

The new method tends to give weight to sub-class means more in proportion to the numbers on which they are based than does the method of weighed squares of means. When the number of sub-classes are large the time and effort saved by the proposed method may outweigh the loss of efficiency.

2. Some Aspects of the Comparisons of Experiments.

David Blackwell; *Howard University, Washington, D. C.*

A set of n alternative hypotheses about the distribution of a variable with k values is specified by an $n \times k$ matrix $P = [P_{ij}]$, called an experiment, where P_{ij} is the probability of value j under hypothesis i . For two experiments P and Q with the same n , two equivalent formulations are given for the concept that P is more informative than Q , writ-

ten $P \supset Q$. For $n = 2$, i.e. testing a simple hypothesis against a simple alternative, let $\beta_P(\alpha)$ be the probability of a type two error in experiment P using the Neyman-Pearson likelihood ratio test at level α . For this case $P \supset Q$ if and only if $\beta_P(\alpha) \leq \beta_Q(\alpha)$ for all α . This fact yields that $\beta_P(\alpha) \leq \beta_Q(\alpha)$ for all α implies $\beta_{P,r}(\alpha) \leq \beta_{Q,r}(\alpha)$ for all r, α , where $(P, r) [(Q, r)]$ is the experiment with r independent observations of $P[Q]$. Some normal and binomial examples are given.

3. Quality Control Applied to Routine Counting of Bacterial Plates.

Clifford J. Maloney; *Camp Detrick, Frederick, Maryland.*

A special experiment on factors affecting the accuracy of routine counts of bacterial plates revealed the presence of erratic disturbances which increased the coefficient of variation to about 3 times the theoretical value given by the Poisson distribution. When plotted on a quality control chart these values appeared as points out of control not only compared to theoretical control limits calculated from the Poisson distribution but compared to observed limits based on the 3-fold inflated variance. On the basis of this result a trial was made of quality control applied to the regular counts of the laboratories. Calculations were done on a Remington Rand punched card installation, the quality control results being obtained as a by-product of other required calculations. While it was not possible to isolate specific sources of increased variability in the counts, the Poisson index of dispersion was reduced to about one and one-half the theoretical value. It was found that expressing the observed index as a per cent of theoretical made it quite easy for applied people to grasp the significance of the result. Recently a scheme involving a probability scale has been tried.

4. Paired Comparisons in a Lattice Design.

Boyd Harshbarger; *Virginia Polytechnic Institute.*

This is a design for factorial experiments in which the treatment combinations are grouped in pairs and contains the features of the "Latinized Rectangular Lattices" (see Biometrics, The Biometric Society, March 1952, Vol. 8, No. 1). It enables the estimation of variability between rows and columns and at the same time gives efficient adjustments to the incomplete blocks. Following the adjustments involved in the "Latinized Rectangular Lattices" standard significance tests can be made using the principles of factorial designs. The theory is applicable to a larger number of treatments.

These designs have great possibilities for factorial problems in certain animal experimentation, in some food experiments, and in some special agronomic problems where two-way variability must be removed before studying the factorial effects.

5. Multiple Range Tests and the Multiple Comparisons Test (A Preliminary Report).¹

David B. Duncan; *Virginia Polytechnic Institute.*

Several methods are available for testing differences between treatments in an analysis of variance. The two considered most satisfactory are one by Newman (1939) and Keuls (1952) and the Multiple Comparisons Test by Duncan (1951). Both employ repeated homogeneity tests. The Newman-Keuls test is simpler because it uses repeated range tests instead of F tests as used by the Multiple Comparisons Tests. The latter is generally more sensitive owing partly to this reason but mostly to the relaxation of the significance levels of some of the tests considered to be of diminished importance. This paper presents: a new Multiple Range Test which achieves the simplicity of the Newman-Keuls test by using range tests and most of the sensitivity of the Multiple Comparisons Test by using the special significance levels, and an improved set of application rules for the Multiple Comparisons Test. Each of these is recommended for use depending on the relative needs for simplicity or sensitivity. The special system of significance levels is discussed in some detail. The author is indebted to W. Beyer in the determination of significance ranges for the new test which is still in progress.

6. The Air Force Univac System.

Joseph V. Natrella; *United States Air Force.*

The purpose of the Air Force Univac System is to assist in solving a difficult management problem — planning the operations of the Air Force on a business-like basis. Its use can result in a great reduction in the time and man hours needed to test program implications. Magnetized tape spots are used to communicate with the machine. These coded spots are compact storage for alphabetic and numeric data. The Unityper types characters on tape. Uniservos read data on tape into machine storage registers. They can also write information on tape from the registers. The central computer contains the storage register memory and the arithmetic unit for computation. High speeds are a result of electronic tubes and electronic circuits. Human control is exercised by a switch console, supervisory control. Its lights can show the operator what is being done at various problem stages. Results recorded on tape are translated into typewritten copy by the uniprinter. The card-to-tape converter transcribes data from punch cards to magnetic tape. Instructions must be prepared for the machine to compute. This coding must precede the computation, and provide the automatic control of the computer.

7. Computation of a Linear Programming Problem.

Lt. James V. Kelley; *United States Air Force.*

¹ Sponsored by the Office of Ordnance Research, United States Army.

The linear programming problem considered in this paper is as follows: Given a system of linear inequalities and a linear form; find a non-negative solution to the linear system for which the greatest lower bound of the linear form is obtained. The background of the problem is explained in terms of its application to certain optimization problems in military planning.

The paper describes the so-called "simplex" method of solution which, although derived for only a small class of problems termed non-degenerate, generally yields optimum solutions. Certain inadequacies of the technique are mentioned, and it is shown that the method compares favorably with the elimination technique for inverting matrices.

Finally, the use of an electronic computer (Univac) to solve the problem is discussed. Some of the computational difficulties involved in solving large systems and some of the results of problems solved are given. Variations and extensions of the original problem are briefly mentioned.

8. Extension of the Multiple Comparisons Test to Incomplete Block Designs-II.²

Edwin Bleicher and David B. Duncan; *Virginia Polytechnic Institute*.

The purpose of this paper is to extend the Multiple Comparisons Test for use in unbalanced lattice designs. A triple lattice with nine treatments and three replications is employed to aid in the development of the test. The Multiple Comparisons Test is not directly applicable to testing the differences between treatment means in this design because of the correlation between the treatments. It is shown, however, that a useful approximation can be obtained by proceeding as though the treatment means were uncorrelated provided the variance of a treatment difference is replaced by one-half the average variance of a difference between two treatments. This result depends on an extension of the material discussed by Sanders and Duncan (see abstract herewith) for balanced lattices. The variance-covariance matrix of the difference between treatment means is determined. It is demonstrated that the covariance between differences not having a treatment in common is zero and the average of the remaining covariances is one-half the average variance of the treatment differences. Thus, the approximate procedure can be used with the same assurance as is customarily associated with the replacement of the individual variances by the average variance of such differences.

9. Some Further Extensions of the Rank Analysis of Incomplete Block Designs. (A preliminary report).

Ralph Allan Bradley; *Virginia Polytechnic Institute*.

The paper is introduced with some comments and comparisons on re-

² Sponsored by the Office of Ordnance Research, United States Army.

cent work on paired comparisons by Fred Mosteller, Henry Scheffe, and the present author with M. E. Terry. One point of emphasis showed that the Mosteller-Thurstone model can be summarized by the integral and the Bradley-Terry Model by

$$\pi_{ij} = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} e^{-1/2 y^2} dy$$

$$-(S_i - S_j)$$

$$\pi_{ji} = 1/4 \int_{-\infty}^{\infty} \operatorname{sech}^2 \frac{y}{2} dy$$

$$-(\log_e \pi_i - \log_e \pi_j)$$

where in each formula π_{ij} is the probability that item i is rated above item j in a paired comparison. S_i and $\log_e \pi_i$ are in the different notations location points for item i on a subjective continuum.

The main body of the paper deals with limiting large sample distributions. Likelihood ratio tests are used for the paired comparisons and the statistic is shown to have a chi square distribution in the limit when the null hypothesis is true and an asymptotic normal distribution for the power function. The variance and mean of the normal distribution are very complicated functions of the postulated parameters π_i and it is indicated that some further work may be required on this point.

10. Extensions of the Multiple Comparisons Test to Incomplete Block Designs—I.³

Paul G. Sanders and David B. Duncan; *Virginia Polytechnic Institute*.

The Multiple Comparisons Test (Duncan, 1951) is a procedure for testing the differences between ranked treatments in an analysis of variance. It has been designed for the fairly common case in which the treatment means are independent and have the same expected variance. The purpose of this paper is to extend this test for use in balanced lattice designs. It is shown that, although the treatment means in a balanced lattice are correlated, differences between means have a similar variance-covariance matrix to that of differences between uncorrelated means in the following respects. The variance $V(d)$ of each treatment mean difference is constant. The covariance of each pair of treatment mean differences involving a common treatment is the same for all such pairs and is equal to $1/2V(d)$. The covariance between each pair of treatment mean differences not containing a common treatment is zero. From this it is

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shown to follow that a Multiple Comparisons Test may be applied to the differences between correlated treatment means of a balanced lattice by the same method as that used for uncorrelated treatment means provided that the variance of a treatment mean is replaced by $\frac{1}{2}V(d)$.

11. A Modification of the Aitken-Neville Interpolation Formulae.

M. C. K. Tweedie; *Virginia Polytechnic Institute*.

Aitken (Proc. Edinburgh Math. Soc., series 2, 3 (1932), 56) has described an interpolation procedure which is convenient for use with a desk calculator and requires neither that either variable should be tabulated at uniform intervals nor that differences need be calculated. Neville (Journal Indian Math. Soc. (1933), 87) has given a modification of the same idea, and the present paper gives a further alternative. Each version has some advantages over the others. Aitken's general technique computes a succession of interpolates, each giving the same result as fitting a polynomial to all the values on which it is based. These interpolates are each obtained by a method equivalent to a linear interpolation between two interpolates (chosen by different rules in the three versions) obtained at an earlier stage in the process. The required interpolate appears at the ultimate stage when every given value has been included, and is the same by all three methods. The new method generally provides intermediate interpolates which are closer approximations to the ultimate interpolate than do the Aitken and Neville procedures at corresponding stages, and are the most satisfactory if the computations may later need extending to give an ultimate interpolate of higher order.

12. Quartermaster Board Test of a Detergent.

Elie Weeks; *Quartermaster Board, Fort Lee, Virginia*.

During the period from December 8, through March 20, the Quartermaster Board, Fort Lee, Virginia, conducted a user test of a new type of detergent at 10 Army posts located in hardwater areas of the middle-west and far-west. The purpose of the test was to determine: (1) The optimum concentration for washing dishes, pots or pans, and woodwork; (2) The efficacy of soil removal; (3) The ratio of that used compared with G. I. bar soap; (4) Economy of storage and shipping space; and (5) The effect on the hands of the users. Test data was generated by means of questionnaires, interviews, and weighing the amount of G. I. soap and detergent used for cleaning operations. Objective data on efficacy of soil removal from dishes and trays was obtained by staining washed utensils with a fluorescent dye (primuline) and exposing them to an ultra-violet light.

13. Use of I. B. M. Equipment in Statistics.

Richard G. Cornell, *Virginia Polytechnic Institute*.

When it is necessary that an arithmetic process be done repeatedly,

I. B. M. equipment may save both time and labor. Such situations arise in statistics in the computation of tabular values corresponding to different values of independent variables and in the analysis of variance. This paper is mainly concerned with the use of I. B. M. equipment in the computation of significance levels for certain experiments designed by Bradley and Terry at the Virginia Polytechnic Institute to test subjective data. Besides a series of several thousand multiplications and additions, these computations involved an iterative process for solving equations in several unknowns. I. B. M. equipment was used to record data on cards, to group data, and to list results as well as to do the actual computation.

14. The Analysis of Variance on I. B. M. Calculators.

Robert M. Abelson; *Virginia Polytechnic Institute*.

The purpose of this paper is to demonstrate the calculations necessary in an analysis of variance on automatic equipment. When data is presented in mark sense form on punched cards, a substantial saving in time needed for calculations may be obtained by the use of punched card calculators. This method will also result in an increase in accuracy over the use of desk calculators due to the tedious calculations of sums of squares. This method is particularly useful when a large number of separate analyses are to be done at the same time.

15. Certain Percentage Points of the Distribution of the Range of Large Samples.⁴

William H. Beyer; *Virginia Polytechnic Institute*.

This paper is concerned with the derivation of $100\alpha_n$ percentage points of the studentized range, where $\alpha_n = 1 - (1 - \alpha)^{n-1}$, $\alpha = .05, .01$, $n = 2(1)20$. These values are required for multiple range significance tests.

The studentized range is defined as $q = w/s$. Here w is the range in a random sample of size n drawn from a normal population with variance σ^2 , and s^2 is an estimate of σ^2 with ϕ degrees of freedom.

We use $\phi P_n(Q)$ to denote the probability that the variate q will not exceed any fixed value Q . The required significance points for Q satisfy $\phi P_n(Q) = 1 - \alpha_n = (1 - \alpha)^{n-1}$, and can be formed by inverse interpolation from values of $\phi P_n(Q)$ computed at suitable trial values of Q . Tables of $P_n(Q)$, $a_n(Q)$ and $b_n(Q)$, for $n = 2(1)20$, have been given by E. S. Pearson and H. O. Hartley (*Biometrika*, 33, (1943-46), 89), by which $\phi P_n(Q)$ has been computed by H. O. Hartley's (*Journal of the Royal Society Supplement*, 5, (1938), 80; *Biometrika*, 33, (1943-46), 173) approximate formula

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$$\phi P_n(Q) = P_n(Q) + \frac{1}{\phi} a_n(Q) + \frac{1}{\phi^2} b_n(Q),$$

with $\phi \geqslant 10$.

For smaller values of ϕ , it has been necessary to add a term in $\frac{1}{\phi^3}$ to this formula. This paper includes an account of the derivation of this new approximation by a somewhat more direct method than Hartley's.

16. Confidence Intervals for the Differences Between Treatment Means in an Analysis of Variance.⁵

Robert G. Bonner and David B. Duncan; *Virginia Polytechnic Institute*.

A comparison is made of several of the available procedures and that of a proposed new method for obtaining confidence intervals for the differences between treatment means in an analysis of variance. The new method is an extension of the Multiple Comparisons Test, Duncan (1951). The intervals obtained are complex in that the limits for each difference are functions of the expected values of the remaining differences. Alternative methods for resolving these complexities are discussed. In each case the resulting intervals are shorter than those of the previous methods.

BUSINESS MEETING

The following were elected to serve as officers of the Section of Statistics for 1953-1954.

Chairman: Ralph A. Bradley

Vice-chairman: William Cooke

Secretary: C. Y. Kramer

⁵ Sponsored by the Office of Ordnance Research, United States Army.

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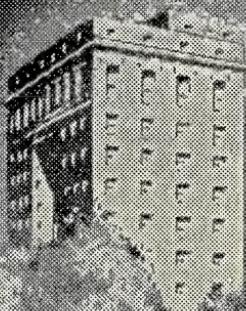
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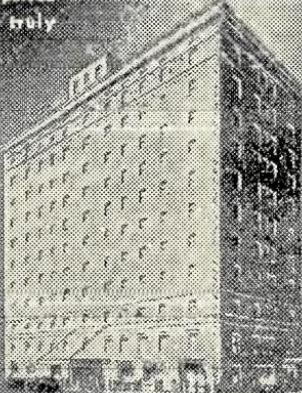
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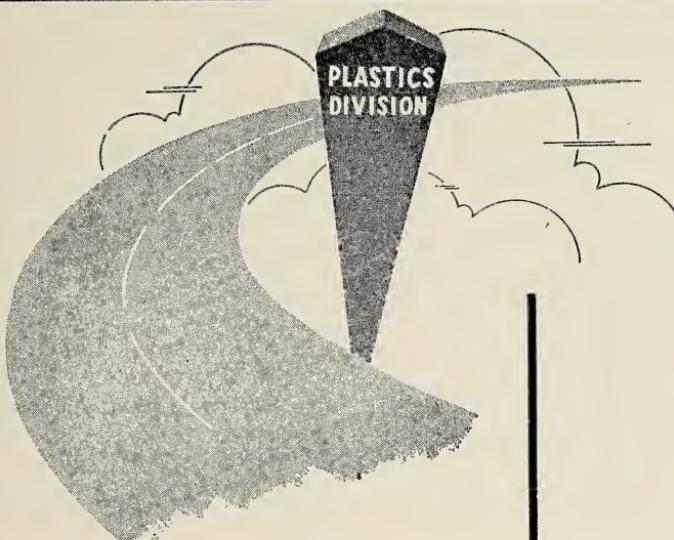
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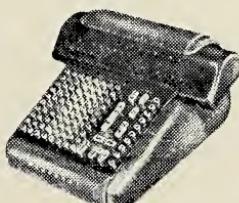
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C O N T E N T S

	Pages
Factors Influencing the Growth of Research in Southern Universities — GEORGE F. GANT	1
A Study of Dogs as Vectors of <i>Salmonella</i> in the Area of Richmond, Virginia — WILLIAM PAUL BENNETT	12
General Equation for Conics and Pseudoconics R. E. HERRON and D. S. DAVIS	17
Phosphate Ion Uptake by Human Red Cells — D. R. H. GOURLEY	20
Minimum Sums of Squares when the Two Extremes are Retained — PRASERT NA NAGARA	22
News and Notes	29

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THE VIRGINIA JOURNAL OF SCIENCE

VOL. 5, NEW SERIES

JANUARY, 1954

No. 1

Factors Influencing the Growth Of Research In Southern Universities

GEORGE F. GANT

Southern Regional Education Board

Southern universities face a knotty problem in the development of their graduate research programs. The agricultural and industrial revolution in the South is making heavy demands upon them for a larger number of professional and graduate programs. The vastly improved economic level of the South makes it possible for thousands more young people to go to college and to take advanced work. The consequent growth in graduate education is taking place during a period when funds for research — basic to graduate education — are controlled largely by federal and industrial agencies. This growth is also taking place at the same time as an expansion in undergraduate education, which produces severe competition for money and personnel. The problem inherent in this situation is how to develop programs of research and graduate education of quality when the necessary funds are so hard to get under conditions which preserve the universities' essential freedom and integrity.

Let me illustrate. I have been reading recently about the financing of research in colleges and universities. Two reports have been particularly illuminating: John D. Millett's staff report *Financing Higher Education in the United States* (published 1952 for the Commission on Financing Higher Education by the Columbia Press) and The National Science Foundation's study *Federal Funds for Science: I. Federal Funds for Scientific Research and Development at Nonprofit Institutions* (published 1953 by the U. S. Government Printing Office).

Perhaps the following quotations from these reports, which confirm each other, will startle you as they did me.

"Out of 132 million dollars of [federal] contract research, probably 100 million represented services purchased from universities which only indirectly and to a limited degree added to the educational program of the institutions involved." (Millett, p. 417).

"Based on the data available from this study, it appears that about half of the funds now going to educational institutions

contribute little to the primary objectives of these institutions." (National Science Foundation, p. 3).

"Perhaps the most salient characteristic is the existence of a continuing collaboration between the Government and the contracting organization, as a result of which the Government determines the general objectives and work plans of the center and supplies the funds to operate it, while the contractor provides principally managerial services." (National Science Foundation, p. 9).

"There is scarcely a first-rate physics or chemistry department providing graduate instruction in our universities which could maintain its present standing or personnel without federal income." (Millett, p. 355).

The situation implied in these statements is that the quality and extent of research in universities are determined in large measure outside the universities themselves. Yet research, although by no means a monopoly of universities, is an integral and necessary function which is central to their whole purpose and to their integrity. The ability and freedom of higher institutions and their faculties to seek new truth according to their own decision and within their own competence are basic to the very idea of a university. Moreover, it is of crucial importance to all of us as individual citizens in a democracy, and to the Nation, that the traditional self-determination of higher institutions concerning their research and academic programs be preserved. I believe colleges and universities do have additional responsibilities to devote their resources to the solution of local and national problems. This service function, however, is not only subordinate to, but derives its merit from, the excellence of the research and teaching functions. It should be added, also, that the colleges and universities cannot solve their problem of program determination by ignoring or severing connections with outside sources of support for research. On the contrary, if they are to have strong programs, they are almost obliged to come to terms with conditions and trends as they exist.

*Pattern of Research and Development.*¹—Universities are the junior partners in the Nation's research and development program. The money volume of research and development in 1952 was 3.5 billion dollars — 2.3 billion was expended by industry, .8 billion by the federal government, and .4 billion by nonprofit institutions including colleges and universities. Of about 160,000 research engineers and scientists engaged in research and development projects, 60 per cent were employed by industry, 20 per cent by government, and 20 per cent by universities. Not only are universities the smallest member of the team, they are dependent upon government and industry for most of the funds they are able to get for research. Millett estimated that in 1950 federal contract research performed by colleges and universities was about 60 per cent of their total

¹ Figures in this section are taken from the NSF report referred to above.

expenditures for organized research activities. If we add other federal funds for agricultural and medical research, we find that the government provided about 70 per cent of all the income used to support this part of the work of higher education. This relationship creates major problems for the universities.

The NSF report presents a very clear picture of the volume and character of federal research for the fiscal year 1951-52. In that year federal funds for scientific activities of all kinds totalled 2.2 billion dollars. Of this amount, 295 million dollars were for scientific research and development at colleges and universities. This 295 million dollars went to colleges and universities in three ways: (1) 144 million dollars for twenty-one research centers for which the government sets the objectives and work plans and the universities provide chiefly managerial services; (2) 93 million dollars for purchased research and developmental projects to assist federal agencies to carry out specific responsibilities; and (3) 58 million dollars for sponsored research to support efforts to add to the general fund of scientific knowledge as a matter of public interest.

In view of the amount and proportion of university and college research financed by the federal government, the characteristics of that research are significant.

1. Only 12 per cent, 225, of the 1871 institutions of higher learning received research funds. However, one third of the 687 institutions with a present or potential capacity for research received funds.
2. Five institutions received 55 per cent of the funds; 50 institutions received 91 per cent, with the remaining 9 per cent being distributed among 175 institutions. Of the institutions receiving funds, 17 per cent are in the South. They received 6 per cent of the funds. Six institutions in Virginia received \$1,138,000 in 1951-52.
3. Two-thirds of the total funds were expended in four states — Massachusetts, New York, Illinois, and California.
4. Eighteen federal agencies administer these research funds, although two — the Department of Defense and the Atomic Energy Commission — administer 88.5 per cent of the total.
5. For the most part, each of these several federal agencies selects the institutions to which grants are made on the basis of criteria and procedures it devises for itself.
6. Work in the physical sciences received greatest emphasis — 72 per cent of the total funds — as against 19 per cent for the life sciences, 3 per cent for the social sciences, and 6 per cent for increase of research and development plant.
7. "Directed" research in research centers and "purchased" research was almost 80 per cent — leaving 20 per cent for "supported" or "sponsored" research.

Federal expenditures for research in institutions are, of course, only one of the ways in which federal research and educational activities affect colleges and universities. Millett estimates that in 1950 the proportion of income received from the federal government by all institutions of higher education — large and small, public and private — was 28 per cent of their total income. For universities it was 32 per cent. Payments for veterans' educational benefits were 58 per cent of the \$468,305,675 received by institutions in 1950, and payments for contract research were 28 per cent. Other payments were for experiment stations and agricultural extension and for training programs for federal personnel. These several activities are relevant here because the very magnitude of federal support for higher education is influential in the planning of college and education programs, including their research programs. More particularly, decisions made by federal agencies about what programs should be provided for federal employees, and in what institutions, have a direct bearing on the decisions of the colleges and universities on the specialized programs they will offer.

Finally, with respect to federal activities in research which have an impact on institutions of higher education, it will be recalled that total federal expenditures for research and development in 1951-52 were 2.2 billion dollars. Over 90 per cent of these funds were used to support research and development programs in non-educational agencies — in programs conducted directly by the federal government, in programs supported by the federal government in industrial agencies, and in private and nonprofit institutions. This means, of course, that as far as quantity of research is concerned, the amount done by institutions is dwarfed by that done by the federal government itself — either directly or through other agencies. We are all familiar with the many government research laboratories scattered around the country. A development of the past decade is the construction and operation of major research and development centers — chiefly under contract — in the new and expensive fields such as atomic energy and aeronautics. The extent to which university personnel benefit in their own research and instructional programs from these large centers depends upon their willingness, and success, in making satisfactory arrangements with federal agencies and their contractors. To put it another way, the centers of research leadership and activity, in many fields, have been removed from the universities.

The figures for the extent of research and development activity by industry are not so readily available as are those for the federal government. We do know, however, that in several fields industries maintain their own individuals or joint research laboratories. In oil, for example, and in many of the chemical fields such as plastics and fibers, the major laboratories are industrial and the research and development leadership in these specialized fields is with industry.

Although to a lesser extent than in the case of the federal government, industry also makes gifts and grants to educational institutions. Millett estimates that such funds and other private benefactions, including founda-

tion grants, comprise 6 per cent of the income of universities and colleges. In addition, many grants and gifts go directly to students and faculty members. The availability of these funds, the desires of the donors, and the interest of colleges and universities in getting such funds, all have an impact on institutional research policy and program in much the same way as is true in the case of federal funds.

The general pattern of research and development as it affects universities might be summarized in the following way:

1. An overwhelming part of the scientific research and development being done in the United States today is being conducted by federal and industrial agencies.
2. An overwhelming portion of the scientific research being conducted by universities is financed by federal and industrial agencies.
3. An overwhelming portion of the scientific research financed in universities by government and industry is "directed" or "project" research in the physical and biological sciences.
4. An overwhelming portion of the scientific research financed in universities by outside agencies is conducted by a very small proportion of the universities which have present or potential research capacity.
5. For the most part, federal and industrial payments to institutions are made by many diverse and uncoordinated agencies under policies and procedures (such as selection of institutions) which are obscure.

Impact of Research Pattern on Universities. — Almost every faculty member interested in research has experienced or can anticipate the influence of this national pattern of research and development upon his institution's own research policy and program. A phenomenon in university administration in recent years has been the tendency of many of the larger institutions to organize their research programs more formally — for so-called "organized research". There are several reasons for this trend, but one of the major of them is undoubtedly the problem of negotiating and administering contracts with federal and industrial agencies. One of the chief functions of the institutional research office is ordinarily to solicit funds. This development in university organization obviously has many advantages in that it helps secure support for research of interest to university faculty, handles troublesome legal, administrative, and fiscal matters, and encourages inter-disciplinary cooperation. It should be noted, however, that this organization trend threatens a departure from the traditional manner of treating instruction and research as integral parts of the same essential process of education. In some cases separatism has resulted from the nature of research contracts entered into and the research

organizations established to administer them. In these cases research projects become almost completely disassociated from the central university program, and funds and contracts are solicited, or at least accepted, for their own sake rather than because they support the university program as such.

The peculiar way in which university research is financed makes it difficult for a university to maintain a desirable balance between basic and applied research, on the one hand, and between the physical and life sciences and the social sciences and humanities on the other. As seen, most of the funds available are for applied projects in the physical and biological sciences. It is true that some universities have used "overhead" income from contracts to support the social sciences and the humanities. It is also true that for the most part research in the social sciences and humanities is comparatively inexpensive. Nevertheless, the influence of outside interests and funds create the problem of balance in a university's research and academic program.

Not only the balance of program is involved, but the kinds of research which can be financed are restricted. A large part of it, as seen, is "project" research of an immediate problem-solving type for which are prescribed all kinds of special conditions ranging from frequent progress reports to secrecy. In some instances the faculty member engaged on a research contract may feel that he is more closely supervised by and obligated to the outside agency than to his own institution. Even more threatening, obviously, is the pressure upon faculty to become more interested in research for which funds are available than in research which is more in keeping with their professional instincts and university program.

Not the least of the impacts upon universities of this general situation concerning research is that of competition — competition with other institutions for money and competition with government agencies and industry for personnel. Neither federal agencies nor industries have a coordinated or general policy concerning the widespread distribution of funds for research or even of advertising and eligibility to compete for such funds. This statement is not made to suggest that such policies should be instituted, but to emphasize the peculiar circumstances with which a university must deal in getting support for its research. It operates largely in the dark, flashing its light from time to time on likely sources of funds and keeping in touch, literally, with as many influential people as possible. In many cases, to hold its staff, the university *must* have research contracts, not only to have a research and graduate program of merit in a given field, but to be able to pay its faculty competitive salaries. Further, with respect to personnel, the educational institution must compete not only with other colleges and universities, but with government and industrial agencies as well. Never able to pay salaries as high as those in these agencies, the university must try to stay within at least the range of such salaries and to press its advantages in prestige and working conditions. Because of the serious shortage of scientific personnel, however, the mere hope that universities can compete is illusory. It is becoming

increasingly necessary for universities to work out systematic relations with industry and government so that the limited supply of competent persons can be most productive in the interest of all.

Other problems concerning factors influencing university research could be identified, not the least of which is uncertainty about the continuation of any particular research project and even about the stability of research support in general. Enough has been presented, however, to sketch and illustrate the situation as it has emerged during the past decade or so. It would be unrealistic for universities either to ignore these problems or to attempt to avoid them by refusing outside grants or contracts — they simply would not be able to maintain their research standing. What alternatives are there? That brings us to the situation in the South, which is particularly acute because of the painfully rapid growth in college and university enrollment and program.

Rapid Growth of Higher Education in the South. — The changes taking place in higher education in the South are little short of being phenomenal. Whereas in 1940 there were only 355,000 students (exclusive of summer and special students) in southern colleges and universities, in 1950 there were 603,000 — an increase of 70 per cent. The sudden increases were due in part to the large veteran-student group immediately after World War II. After a couple of years of decreasing enrollments, the number of students is rising again. The figures for the past thirty years show that the South's enrollments, though still lower, are increasing more rapidly than those of the Nation as a whole.

The future will bring an even larger growth. The population experts estimate that the Nation's college age population will increase to 10,000,000 by 1960 — a rise of 16 per cent from 1950 — and to 14,000,000 by 1970, which is a jump of 60 per cent from 1950. The educational statisticians think that the number of college students will level off at about 25 per cent of the college age population — it was 21 per cent in 1950, 16 per cent for the South. In applying these trends to the South, I will assume that the region's proportion of the Nation's college-age persons will decline from its 33 per cent in 1950 to 32 per cent in 1960 and to 30 per cent in 1970. I feel safe in doing so because the change in the southern economy from agriculture to industry, with higher incomes, will bring the balance in population to more nearly that predominating in the Nation as a whole. In addition, for our purposes here, it is conservative to estimate a lower proportion of college-age youth. I will also assume that the number of the South's college students will increase from 16 per cent of the college-age group in 1950 to 21 per cent in 1960 and to 25 per cent in 1970. This assumption seems warranted because of the progression of the past thirty years, which shows the South about ten years behind the Nation in educational trends of this kind, but more particularly because of the economic advances already referred to, and because of the rapid equalization of educational opportunities for Negroes.

Based upon these two assumptions, the number of the South's college students will increase by 70,000 by 1960 — to 670,000 students — and by

450,000 above 1950 to a total of 1,050,000 students in 1970. This is an increase of three-fourths over 1950 enrollments and amounts to three times the 1940 enrollments; the increase alone is almost 100,000 more students than were in college in 1940.

As startling as these increases are, the growth in the number of graduate students in southern universities is much greater in proportion, and most significant for our purposes here. Whereas the total number of students increased by 70 per cent between 1940 and 1950 and will increase by 75 per cent between 1950 and 1970, the number of graduate students more than doubled between 1930 and 1940, and it tripled between 1940 and 1950 — from 10,500 to 34,000. In 1950 five and one-half per cent of the South's college students were taking graduate work. In the Nation as a whole, six and one-half per cent of the college students were taking graduate work ten years earlier, in 1940, and nine per cent in 1950. If the trends in the South continue, and if the South continues to duplicate the Nation's experience, the proportion of the South's students in graduate work will reach nine per cent in 1960 — 60,000 — almost twice the number of 1950. If the proportion were not to increase at all between 1960 and 1970, the number would increase to 90,000. I think it reasonable to assume that the proportion will increase to twelve per cent, or to 126,000 graduate students in southern universities in 1970. This is almost four times as many as there are now.

There are other evidences of rapid change in higher education in the South which have their bearing on graduate education and research. More and more graduate and professional courses are being offered to satisfy the needs of the southern states which are parties to this virtual agricultural and industrial revolution which is producing higher income levels to support demands for professional and technical education in a large number of diverse fields. A review of growth of colleges and universities in the South between 1946-47 and 1950-51 illustrates the changes which are taking place:

1. The value of buildings, grounds, and equipment per student compares favorably with the national average.
2. The number of volumes in libraries increased from 17.3 million to 23.7 million — 37 per cent. The total amount spent annually for books and periodicals increased from 2.7 million dollars to 4.3 million dollars — an increase of 61 per cent.
3. The number of faculty members with doctor's degrees increased by more than 50 per cent — from 32 per cent of the faculty in 1947 to 38 per cent in 1951.
4. The number of graduate students increased from 17,700 to 39,000 — an increase of 120 per cent.
5. Whereas the number of bachelor's and first professional degrees awarded increased 59 per cent, the number of mas-

ter's and second professional degrees awarded increased 143 per cent and the number of doctor's 90 per cent.

Perhaps somewhat similar comparisons for Virginia would be of interest. Whereas there were 23 accredited four-year colleges and universities in Virginia in 1947, there were 25 in 1951. The percentage of Ph.D.'s on the faculty increased from 31 to 36. While undergraduate enrollment declined by 19 per cent, graduate enrollment increased 144 per cent. The increase in bachelor's degrees awarded was 33 per cent, in master's degrees 106 per cent and in doctor's 56 per cent. The amount spent for books and periodicals increased by one-third.

The growth in the graduate and research programs of southern institutions is coming at the same time as an exceptionally rapid growth in undergraduate education, and during a period when competition for funds is keen. The exact costs of graduate education are not known, but it is known that they are substantially higher than those of undergraduate programs. The bill for higher education as a whole is overwhelming, and the total is of concern to us here. In 1950, \$374,000,000 was expended by southern institutions of higher education for educational and general purposes. If expenditures increase by about the same proportion as the increase in the number of students — by three-fourths — the total bill in 1970 will be \$654,500,000 — \$280,500,000 more than for 1950 and about two and one-half times the expenditure in 1940. Higher education is expensive and graduate education is even more expensive. The figures I have given do not include any additional sums needed to improve the quality and to extend the scope of graduate education.

Universities Can Cooperate to Cope with Factors Influencing their Research Programs. — The preceding sections outline the pattern of research and development in this country and the problem which that pattern poses for the individual university, particularly the southern university. The problem, broadly stated, is how the university can retain its freedom, integrity, and leadership in research in face of a shortage of funds and under the weight of the research programs of federal and industrial agencies. I believe the universities must join hands to cope with factors which are too large and diffuse for the individual institutions to handle.

The intellectually free university is an essential part of the foundation of our society and culture. This freedom has attracted the confidence and reliance of the American people and has helped to stimulate heavy demands for service and a tremendous growth in enrollment. The individual university can no longer exert enough leadership or strength, by itself, to deal adequately with the forces in the environment which shape its program. The single institution is not able to influence sufficiently, or with enough assurance, the policies or practices or programs of government and industry. I think that the only way in which the leadership of each university can be expressed, and its freedom and integrity protected, is in the company of its sister institutions. It is only through inter-university cooperation that it can participate responsibly, accountably,

and effectively in the formulation, with government, industry, and professional organizations, of those policies, methods, and programs which are now dependent upon it and others for execution but in the formulation of which it has too little voice. Such cooperative arrangements will not suffice if they are for protective purposes, or for competitive purposes, or for general purposes. They must be arrangements for constructive and specific leadership in connection with particular issues and programs.

Neither is the single institution any longer in a position to inaugurate and conduct specialized programs of advanced research and instruction without regard for the programs already under way in its sister institutions in the region. The costs of such programs are too great and the competition for available funds is too keen to permit the development of such specialized programs which needlessly duplicate each other and which, by the dispersion of funds, lead to mediocrity in too many fields and to excellence in too few.

In the South, the Southern Regional Education Compact was organized by fourteen states to encourage universities to avoid unnecessary duplication by sharing the development of strength in costly specialized programs in professional and graduate fields, and through their cooperative arrangements, to be able to work more effectively and more influentially with federal and industrial agencies. The education compact, although it originated in the South, is not unique in the South. The far western states are also encouraging inter-university cooperation under an inter-state compact. The New England states and the western provinces of Canada are in the process of forming inter-institutional and inter-governmental arrangements for the same purposes.

The Southern Regional Education Compact is not regulatory; it exercises no authority over any educational institution or government agency. Rather, it functions by encouraging the universities to formulate regional agreements, under which those interested share in the conduct of specialized programs so that they more effectively supplement each other and more adequately serve the region as a whole; it systematizes the regional programs in agreements among the universities and the Board; it secures recognition and support of the programs in the several states; and it provides regional backing in coordinated relationships with government and industrial agencies.

Such regional programs are now in effect in ten fields — medicine, dentistry, veterinary medicine, social welfare, nursing, forestry, pulp and paper technology, marine sciences, city planning, and petroleum sciences. About two-thirds of the South's universities are parties to one or more of the agreements under which these programs are conducted. Organized studies are now under way to examine the feasibility of such programs in about twenty additional fields such as architecture, statistics, government, foreign affairs, public health, agriculture, and psychology.

Each regional program has three related objectives:

1. To get the best results out of the cooperation of those universities specializing in a given field. There are six schools of forestry in the regional program of forestry, for example, three in city planning, seven in petroleum sciences.
2. To develop courses and services to meet the needs of all the fourteen Compact states so as to make the establishment of additional specialized programs unnecessary unless special circumstances so require.
3. To develop collective relationships with the governmental, industrial, and professional agencies, with the backing of the region through the Southern Regional Education Board, under which the policies, procedures, and programs of these outside agencies can be more adequately planned and conducted, insofar as they involve university participation, with mutual regard for academic integrity as well as particularized research and educational results.

The Compact Program is young, only five years old, but it has already demonstrated promise as a method by which southern universities can collaborate in meeting their major problems of money and outside influences in developing their programs of research and graduate education. There are other forms of inter-university cooperation, also, which have shown their utility in helping the individual institution maintain its integrity in the face of a changing environment. As the southern universities grow in the scope and quality of their work, and in the extent of their social and economic leadership, it is imperative that they continue, expand, and strengthen their collaboration so that together they can give assurance that each of them is better able to preserve the freedom and integrity for which we depend upon them.

A Study of Dogs as Vectors of *Salmonella* In the Area of Richmond, Virginia

WILLIAM PAUL BENNETT

University of Richmond

Reports have recently appeared in the literature showing that animals of various types may serve as vectors in the transmission of *Salmonella* infections to man. Investigations made on the intestinal flora of birds, cattle, horses, swine, and rodents have demonstrated the fact that these animals are potential reservoirs of many *Salmonella* organisms capable of producing infections in man. Casperson (1937), Magnuson (1938), Kauffmann and Henningsen (1939) identified the dog as the probable source of infection to human beings having salmonellosis. Since these reports others have attempted to determine the percentage of the animals carrying *Salmonella* species and to determine the nature of bacterial organisms carried by dogs. Wolff (1947) reported an eighteen per cent infection in the first hundred dogs he examined. Craige (1948) reported the isolation of two *Salmonella* organisms from two-hundred rectal cultures of dogs. Then Kintner (1949) examined seventy-one dogs in the Ohio State University Clinic and found eighteen per cent of these dogs to be positive for salmonellosis, agreeing with the results of Wolff. In the same year Cruickshank and Smith (1949) examined five-hundred dogs from a kennel which cared for stray dogs, and established the rate of infection with *Salmonella* as one per cent.

The most extensive and recent work done in this field has been reported by Galton, McElrath, Stucker, and Hardy (1950) of Jacksonville, Florida. Their continuous research in the state of Florida deals with impounded, hospitalized, and kennel dogs, thus giving them a cross section of the stray, pet, and racing greyhound dogs in this State. Depending upon the locality from which the dogs were derived, they reported an infection rate varying from 2.6 per cent to 71.4 per cent in stray dogs; 0 per cent to 36.1 per cent in the hospitalized animals; and 6.2 per cent to 93.1 per cent in the racing dogs.

From the literature cited, it is evident that there is still a need for more comprehensive studies of dogs as potential carriers of *Salmonella* infections. In addition, no attempt has been made to survey the *Salmonella* organisms that might be found in the dogs of the Richmond, Virginia, area. For this reason the writer has undertaken a study of *Salmonella* species isolated from 500 normal dogs of the Richmond, Virginia, area, divided equally between stray and pet individuals. The writer hopes the findings herein reported will constitute a contribution to the knowledge of *Salmonella*-dog-man relationships.

MATERIALS AND METHODS

This study is based upon organisms isolated from the feces of 500 normal dogs, which showed no signs of diarrhea, vomiting, or temperature. Two hundred and fifty of these animals were impounded either in the Richmond City Pound or in the Medical College of Virginia research laboratories, which received its animals directly from the pound. These could be assumed stray animals which had enjoyed the free run of the streets. The other 250 animals were hospitalized in the Broad Street Veterinary Hospital. These animals were not ill, but had been admitted to the hospital for grooming, immunization, and other normal procedures. These dogs could be assumed to be well-cared-for pets. Only those dogs which had been hospitalized or impounded for less than five days were examined to lessen the possibility of the dogs becoming infected while impounded or hospitalized.

The feces were collected from the stray animals by means of sterile wooden applicators. These applicators were used as probes in collecting the feces from the rectum of the animal. The probe was then immersed in 10 cc. amounts of differential broth as described below. The specimens from the pet dogs were collected essentially in the same manner by the veterinarians of the Broad Street Veterinary Hospital, except that they employed a steel probe in preference to the wooden probe.

The methods and media used in this survey to culture these stools were very similar to those used by the Communicable Disease Center in Chamblee, Georgia; but a few modifications which were employed by Galton, Hardy, and Mitchell (1950) were introduced.

Immediately after the stools were collected, one to two grams of the feces were introduced into brilliant green tetrathionate broth. *Salmonella-Shigella* agar, brilliant green agar, and MacConkey's agar were used for cultivation and isolation of the *Salmonella* organisms. All non-lactose fermenting colonies were tested on triple sugar iron agar. Presumed *Salmonella* positives were confirmed by inoculating urea broth.

The cultures giving a negative reaction on the urea were retained; and lactose, sucrose, salicin, aesculin-adonitol-salicin-sucrose, dextrose, and tryptone media were inoculated with the remaining cultures. The remaining suspected cultures were then subjected to more biochemical reactions on maltose, mannitol, xylose, gelatin, and litmus milk. All of the suspected positives were then subjected to serological examination. If any culture did not give an agglutination on either or both polyvalent and grouping "O" sera, its biochemical properties were checked as well as using *Paracolotn intermedium* serum, which was provided by Galton (1951). If it still gave a typical *Salmonella* reaction, it was sent with the other positives, which had been grouped, to the Communicable Disease Center, Chamblee, Georgia, for identification as to species.

RESULTS

Thirteen cultures, which were isolated from eight dogs, were sent for identification and all were reported as *Salmonella* organisms. These are

listed in Table I. In one case where two species were isolated from the same dog, there was a double infection, including *Salmonella montevideo* and an undescribed species of *Salmonella*.

TABLE I.—SEROLOGICAL IDENTIFICATION OF ISOLATED ORGANISMS
PET DOGS

Number	Polyvalent	Group	Organisms
7-S-B	P	B	<i>S. typhimurium</i> var. <i>copenhagen</i>
7-B-B	P	B	<i>S. typhimurium</i> var. <i>copenhagen</i>
157-T-B	P	G	<i>S. worthington</i>
189-T-B ₁	P	C ₁	<i>S. montevideo</i>
189-T-B ₂	P	C ₁	<i>S. montevideo</i>
189-T-B ₃	P	E	<i>Salmonella</i> species
191-T-B	P	E ₃	<i>S. senftenberg</i>
193-T-B ₁	P	C ₁	<i>S. montevideo</i>
193-T-B ₂	P	C ₁	<i>S. montevideo</i>

STRAY DOGS

108-T-M	P	G	<i>S. worthington</i>
108-S-M	P	G	<i>S. worthington</i>
125-S-M	P	B	<i>S. typhimurium</i> var. <i>copenhagen</i>
214-T-M	P	E ₁	<i>S. anatum</i>

NEW SPECIES

It will be noted in Table I that isolate 189-T-B₃ is an unidentified type of *Salmonella*. This species was isolated from a 4 year old pet dog on February 29, 1952, and was reported by Dr. Edwards at the Communicable Disease Center as having serological characteristics of a new species of *Salmonella*. This organism was studied by Dr. Edwards; and the proposed name of *Salmonella westhampton*, for the section of Richmond, Virginia, in which it was found, was accepted by him.

The biochemical characteristics of *Salmonella westhampton* are as follows:

No reaction after thirty days on lactose, sucrose, salicin, aesculin, adonitol, inositol, inulin, raffinose, and dextrin.

Acid and gas produced from dextrose, dulcitol, rhamnose, mannitol, xylose, maltose, sorbitol, arabinose, mannose, fructose, galactose, trehalose, and glycerol.

Hydrogen sulfide not produced.

Indol not produced.

Nitrate reduced to nitrite.

Litmus milk changes from slight acidity in 24 hours to alkaline in 48 hours.

Nutrient broth is turbid with sediment in the bottom of tube.

Citrate is utilized.

Potato slant has tan, glistening growth.

Agar colonies are circular, bluish-gray, and transparent.

Agar slant has a smoky-gray, smooth, glistening growth.

The provisional antigenic formula as reported by Dr. Edwards is III,
X : g, s . . .

SUMMARY AND CONCLUSION

This survey, based upon 250 pet dogs and 250 stray dogs, indicated that 5 of the 250 pet dogs and 3 of the 250 stray dogs were positive for *Salmonella* organisms. There was a total of eight *Salmonella* infections among the 500 dogs. These results constitute a two per cent infection for the pet dogs, a 1.2 per cent infection for stray dogs, and an overall percentage of 1.6 per cent for all the dogs examined. If these figures are projected into the total number of pet dogs licensed in 1951, there is evidence that 380 dogs of the 19,000 are carriers of *Salmonella* infections. The computed number of stray dogs which are carriers of the infection is 228 among a total of 19,000. The latter number is approximately the number of stray dogs which were picked up during the year 1951 by the City Dog Pound. Thus, out of 38,000 dogs in the City of Richmond, Virginia, there are theoretically 608 asymptomatic dogs which are carriers of *Salmonella*. It must be noted that the number of dogs quoted above is only an approximate number which was given to the author by the license bureau and by the City Dog Pound. The reason for the inaccuracy of the numbers in regard to the pet dogs is that not all of the people in Richmond bothered to have their dogs licensed, even though it is required by City law. The inaccuracy in the number of stray dogs is due to the fact that it is almost impossible for the dog pound to pick up every stray dog in the area of Richmond.

These results cannot easily be compared with other reported results because most of the authors did not state the type of stools used or the condition of the dogs examined. Craige (1948), however, stated that he obtained a one per cent infection in healthy pet dogs in California. These results are not too divergent from those obtained in this survey. Further, Cruickshank and Smith (1949) reported a one per cent infection in healthy stray dogs in London, which is consistent with the data of this survey.

If diarrheic stools had been run concurrently with the normal stools, there probably would have been a higher percentage of infections; however, that was not the purpose of this survey. Findings, herein reported,

indicate that dogs are reservoirs for *Salmonella* organisms which are capable of infecting man.

Since man and dog are usually close companions, it is possible that this may present a real public health problem. Inevitably, the dog, either directly or indirectly, comes into contact with food eaten by human beings; also the dog has the habit of licking people in the face as an expression of affection, and in this manner may communicate infection directly to man. It is evident, therefore, that the potential danger of normal dogs transmitting Salmonellosis as well as other infections associated with man is sufficiently great to include the dog as an animal worthy of public health concern.

ACKNOWLEDGMENT

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General Equation for Conics and Pseudoconics

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A simple construction that makes use of a circle has been shown to yield the parabola, hyperbola, and ellipse (1). An extension of this construction results in pseudoconics shown as La Tosca, Cavaradossi, Bocanegra, and Amelia (2). The present paper covers derivation of a general equation applicable to both conics and pseudoconics.

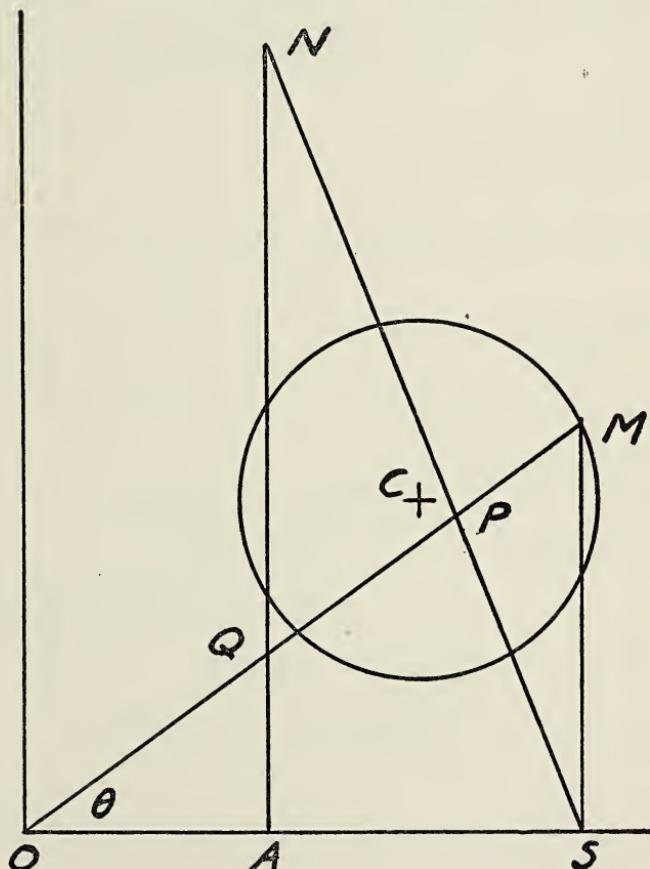


Fig. 1

In Figure 1 consider a system of rectangular coordinates with origin at O. Let C with coordinates (h, k) be the center of a circle of radius a

and let $N(f, g)$ be any point. From M , any point on the circle, draw OM and then draw MS and NA perpendicular to the x -axis. Let NS intersect OM at P and let NA intersect OM at Q . As M moves about on the circle, P describes either a conic or a pseudoconic. Let O also be the center of a system of polar coordinates and let OM make the angle θ with the x -axis. If $OM = R$, the equation of the circle is

$$R^2 - 2R(k \sin \theta + h \cos \theta) + (h^2 + k^2 - a^2) = 0$$

from which

$$R = k \sin \theta + h \cos \theta \pm \sqrt{k^2 \sin^2 \theta + hk \sin 2\theta + h^2 \cos^2 \theta - h^2 - k^2 + a^2}.$$

Let $OP = r$

$$OP = OM - PM$$

$$r = R - PM \quad (1)$$

In the similar triangles NQP and MSP , $\frac{PM}{QP} = \frac{MS}{NQ}$, from which

$$PM = \frac{(QP)(MS)}{NQ}. \quad \text{Since } QP = OP - OQ = r - \frac{f}{\cos \theta}, \quad MS =$$

$R \sin \theta$, and $NQ = NA - QA = g - f \tan \theta$, $PM =$

$$\frac{\left(\frac{r \cos \theta - f}{\cos \theta}\right)(R \sin \theta)}{g - f \tan \theta} = \frac{(r \cos \theta - f)(R \tan \theta)}{g - f \tan \theta} = \frac{r R \sin \theta - f R \tan \theta}{g - f \tan \theta} \quad (2)$$

On substitution of Equation 2 into Equation 1,

$$r = R - \frac{r R \sin \theta - f R \tan \theta}{g - f \tan \theta} = \frac{g R - r R \sin \theta}{g - f \tan \theta}$$

$$= \frac{g R}{g - f \tan \theta + R \sin \theta}, \quad \text{which is the general equation of all curves that result from this construction.}$$

When the center of the circle is at the origin, $h = k = f = 0$, and $g = a$. The general equation reduces to $r = \frac{a}{1 + \sin \theta}$, which, on trans-

formation to rectangular coordinates, becomes $x^2 = a^2 - 2 a y$, the equation of a parabola. When $f = a\sqrt{2}$ and $g = -a$, the general equation reduces to $r = \frac{a R}{a(1 + \sqrt{2} \tan \theta) - R \sin \theta}$, previously shown to be the equation of La Tosca. Similarly, the general equation can be shown to apply to all the other conics and pseudoconics.

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Phosphate Ion Uptake By Human Red Cells

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The general availability of radioactive phosphorus has made it possible to obtain much new information about the exchange of phosphate ions between the plasma and erythrocytes of various species. Kinetic analysis of this exchange has proved more difficult than the corresponding analysis of cation exchange due to certain unique characteristics of phosphate metabolism in erythrocytes. Although a satisfactory kinetic analysis of phosphate ion exchange has not yet been achieved, some of the properties of this exchange have been studied in our laboratory. These studies and our interpretation of them are reviewed briefly in the present report.

When orthophosphate ions labeled with P^{32} are added to whole blood *in vitro* the labeled phosphate leaves the plasma and is taken up by the cells. This is illustrated in Figure 1 in which typical experiments with human, rabbit, and chicken blood at 37° C. have been plotted. Although within a given species the rate of phosphate uptake is proportional to the cell volume, the initial rate of uptake by rabbit and human blood is typically identical in spite of the difference in hematocrits. The uptake of phosphate by the nucleated cells of chicken blood is much slower than the uptake by the mammalian blood cells. In mammalian erythrocytes the energy-producing reactions are mainly glycolytic, whereas in avian erythrocytes oxidative processes ordinarily produce all of the energy. This suggests a possible connection between glycolysis and phosphate uptake, and to pursue this suggestion most of the following information has been obtained using the non-nucleated erythrocytes of human blood.

It was early found (Gourley and Gemmill, 1950) that the absence of the white cells and platelets in human blood did not significantly alter the rate of phosphate uptake. In these studies therefore it was not considered necessary to separate the cellular elements. A further problem was to establish a suitable controlled condition for these experiments. When blood is equilibrated with air as the gas phase the pH rises slightly during the first three hours of incubation and there is a progressive decrease in the total inorganic phosphate (Gourley 1952a). Under these conditions the inorganic phosphate in the cells decreases before any change in the plasma inorganic phosphate can be detected. During this initial period therefore the net movement of phosphate ions is from the plasma into the cells. In addition, the uptake of phosphate has the characteristics of a first-order reaction, as shown by the linear relationship between the percentage of P^{32} remaining in the plasma and time (Gourley and Gemmill, 1950). Except where otherwise noted, experiments were confined to this period of time. No study has yet been made of the movement of phosphate ions out of the cells.

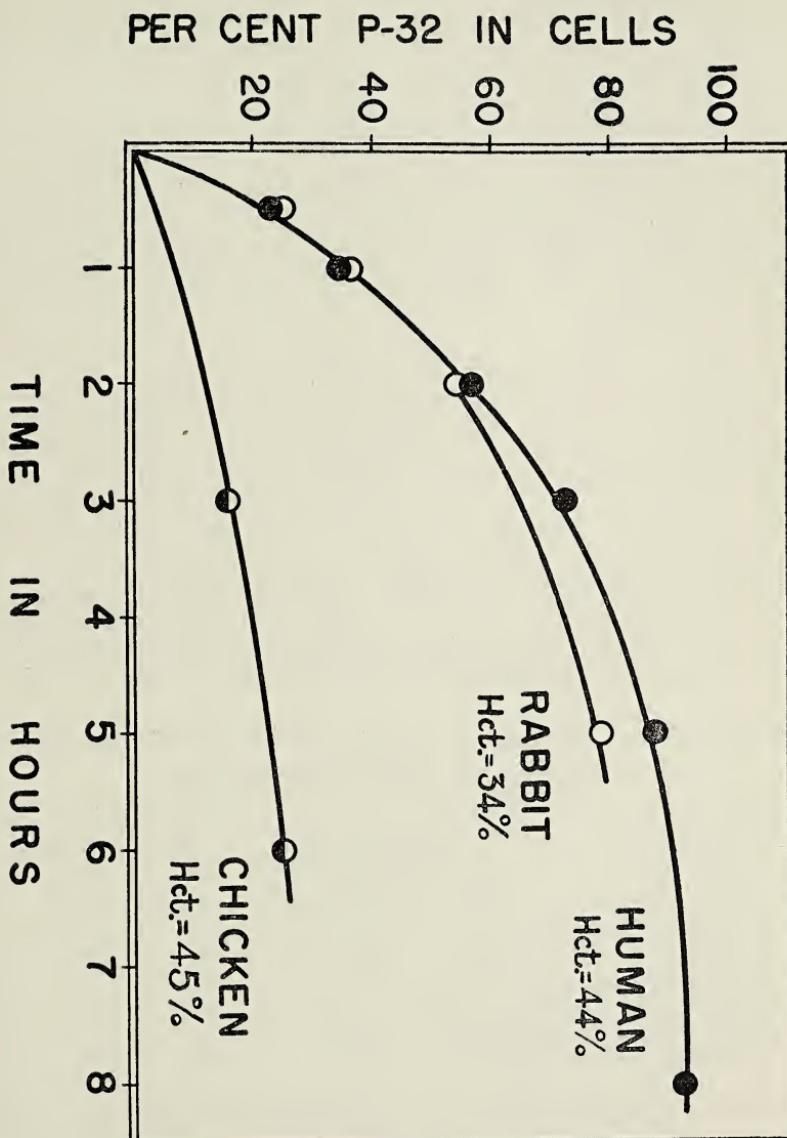


Figure 1.—Uptake of P^{32} -labeled phosphate ions by human, rabbit, and chicken erythrocytes. The hematocrit for the sample of chicken blood was increased from 26% to 45% by discarding some of the plasma prior to the experiment.

As noted above, phosphate uptake by erythrocytes appeared to depend upon the type of metabolism predominant in the cell. Subsequent observations gave further indication that the dominating factor in the uptake of phosphate ions is the cell's supply of energy rather than the physical properties of the cell wall or the phosphate ion itself.

There is a striking effect of temperature on the uptake of phosphate by erythrocytes (Gourley and Gemmill, 1950). There is practically no uptake of phosphate at 15° C. but as the temperature is increased to 40° C. the rate of phosphate uptake also increases. The data fit the Arrhenius equation relating rate and temperature and the activation energy is 16,700 calories. This value is well within the range expected for a chemical reaction and is, in fact, similar to the activation energy of known enzymatic processes.

The effect of phosphate ion concentration on the rate of uptake has recently been investigated in our laboratory by Dr. Jonas. A thousand-fold increase in the phosphate concentration does not increase the rate of phosphate ion uptake. This observation and the temperature effect suggest that phosphate ion uptake does not conform to the laws of diffusion. If diffusion does not play a key role in the uptake of these ions by erythrocytes the alternative possibility is a chemical mechanism. Certain observations give indirect support to this possibility.

The human erythrocyte is generally believed to obtain its energy from the metabolism of glucose (Denstedt, 1953). When the glucose concentration in the blood is reduced by incubating the blood for several hours at 37° C., the uptake of phosphate ions by the cells decreases (Table 1).

TABLE 1.—EFFECT OF GLUCOSE ON THE UPTAKE OF P³²-LABELED PHOSPHATE IONS BY HUMAN ERYTHROCYTES.

Treatment of blood prior to addition of P ³²	Blood glucose	% of added P ³² in cells after 90 minutes
(1) Freshly drawn	90 mg.%	32%
(2) Incubated at 37° C. 9.5 hours	39	21
(3) Incubated at 37° C. 9.5 hours, after which 200 mg.% glucose added	193	32

The addition of glucose returns the phosphate uptake to normal. In addition to its function of supplying the cell with energy, glucose metabolism is therefore apparently necessary for phosphate ion uptake. Assuming that in the human erythrocyte glucose metabolism is mainly glycolytic, it would follow that phosphate uptake, like glycolysis, is independent of the presence of oxygen. This was found indeed to be the case since, in the absence of oxygen, phosphate uptake was essentially the same as it is in the presence of oxygen (Gourley and Gemmill, 1950).

Various steps in the glycolytic pathway can be inhibited more or less specifically by certain chemical substances. Two such substances are iodoacetic acid and sodium fluoride. When glycolysis is completely inhibited with either one of these substances, the rate of phosphate uptake decreases to about one-fifth its normal rate (Gourley, 1951).

All of these features of the uptake of phosphate ions by human erythrocytes implied that chemical reactions rather than physical diffusion alone play a leading role in the process. Beyond the fact that the chemical reactions were glycolytic in nature no information regarding the specific reactions involved had been obtained. In an effort to obtain such information the ultimate fate of the labeled phosphate ions once they enter the erythrocyte was examined (Gourley 1952a). Fortunately most of the labeled phosphate can be recovered in a trichloroacetic acid extract of the cells. Chemical fractionation of this extract revealed that over 70% of the labeled phosphate in the cells was distributed in only six fractions. A time-course study of the ratio of radioactive to stable P (specific activity) in these fractions was made in the hope that the chemical step or steps by which phosphate ions enter the cell might be identified (Figure 2). Based on certain postulates, Zilversmit *et al.* (1943) have derived the conditions necessary in a study of this kind for one substance to be the precursor of another. Briefly, the specific activity of the precursor must be higher than that of the product initially and the two curves must come into equilibrium when the specific activity of the product reaches its maximum.

In the present case the product is cellular inorganic P. It may be seen in Figure 2 that only one of the fractions fulfilled the conditions prerequisite to being a precursor of the cellular inorganic P. This fraction contained the labile phosphate groups of adenosine triphosphate (ATP). Such data do not exclude the possibility that some phosphate ions also diffuse into the cells but strongly indicate that the main pathway is by the formation of ATP at or in the cell membrane.

The effect of iodoacetic acid and sodium fluoride on the various fractions has also been studied (Gourley, 1952b). Both glycolytic inhibitors decrease the concentration of ATP to about 10 per cent of the level in normal blood within three hours. In addition, the turnover of both labile and stable phosphate groups of ATP is significantly reduced by each inhibitor. Thus the same conditions which reduce phosphate ion uptake to one-fifth of the normal rate also decrease the concentration and turnover of ATP. This is additional indication that ATP formation is involved in the uptake of phosphate ions by erythrocytes.

It has already been pointed out that the data presented do not eliminate the possibility that simple diffusion may account for the uptake of some of the phosphate ions. As a matter of fact the uptake of phosphate ions by human blood occurs in at least two phases (Gourley and Matschiner, 1953). There is an initial rapid phase in which less than 20 per cent of the labeled phosphate is removed from the plasma followed by a slow phase which appears to be characteristic of the controlled process

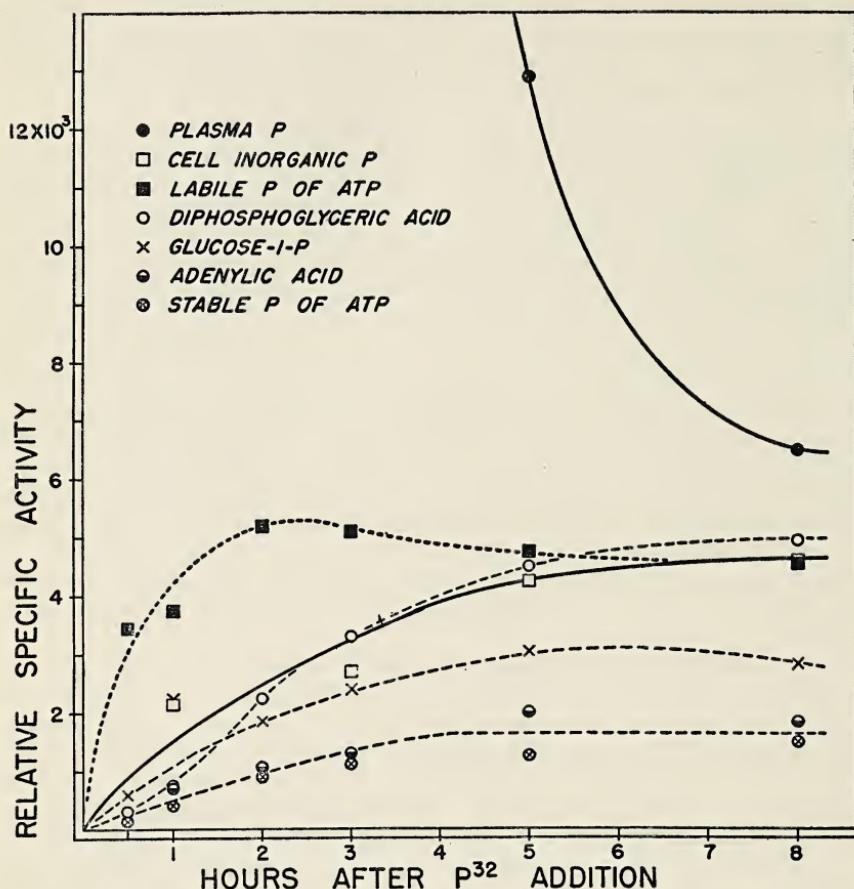


Figure 2.—Time-course of relative specific activity of fractions containing most of the P³² entering human erythrocytes. Relative specific activity expressed as counts/min./mg. P calculated to standard addition of 10⁵ counts/min./100 ml. blood.

by which the larger proportion of the ions are taken up by the cells. Diffusion may therefore account for the uptake of a small proportion of phosphate ions by erythrocytes.

Attempts to demonstrate an enzymatic mechanism for ATP formation at the surface of the erythrocyte have been unsuccessful to date. It is recognized that direct evidence of this sort is needed to prove the hypothesis advanced in this report.

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Minimum Sums of Squares When the Two Extremes Are Retained

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In using Duncan's Multiple Comparisons Test,¹ one has to find whether the sum of squares of each combination of the ranked means, chosen from $\bar{x}_1, \bar{x}_2, \dots, \bar{x}_n$ and including \bar{x}_1 and \bar{x}_n , exceeds a calculated significant magnitude. The work is much reduced, if one can find the combination which gives the smallest sum of squares among m varieties, because if this exceeds the calculated number then the rest of the combinations will also.

Rules: 1. Coding the ranked means $\bar{x}_1, \bar{x}_2, \dots, \bar{x}_n$ (in ascending magnitude) by subtracting the mean of all means, $\bar{x} = \sum_{i=1}^n \bar{x}_i/n$, from each term, one gets the deviations from the overall mean, y_1, y_2, \dots, y_n whose sum is equal to zero.

2. To get the smallest sum of squares among $n-1$ means, one excludes either y_2 or y_{n-1} whichever has the greater absolute value.

3. To get the smallest sum of squares among $n-2$ means, one excludes either (a) y_2 and y_3 , (b) y_2 and y_{n-1} , or (c) y_{n-2} and y_{n-1} . Between (a) and (b), one excludes the values in (a) if $2y_2 > (n - 2 + 1)(-y_{n-1} - y_3)$ and excludes the values in (b) otherwise. Between (c) and (b) one excludes the values in (c) if $-2y_{n-1} > (\overline{n-2} + 1)(y_2 + y_{n-2})$ and excludes the values in (b) otherwise.

4. Similarly, to get the smallest sum of squares among $n-k$ means, one excludes a combination of k means on one or both extremes.

Note: It is advisable to find $S = y_1^2 + y_2^2 + \dots + y_n^2$ first. Then the sum of squares among $n-1$ means excluding y_i is easily shown to be $S - y_i^2 - y_i^2/(n-1) \dots (1)$, and the sum of squares among $n-2$ ranked means excluding y_i and y_j is $S - y_i^2 - y_j^2 - (y_i + y_j)^2/(n-2) \dots (2)$ and so on.

Rule 2 is obvious from (1). A proof for rule 3 is sketched below.

From (2), it is known that the sum of squares of $n-2$ means will be a minimum when $M = y_i^2 + y_j^2 + (y_i + y_j)^2 / (n-2)$ is a maximum. Among all pairs of positive y 's (y_1 not included) y_2 and y_3 give a maximum M . Among all pairs of negative y 's (y_n not included) y_{n-2} and y_{n-1} give a maximum M . If $y_3 > |y_{n-1}|$ then y_2 and y_3 certainly give a maximum M among all pairs. If $|y_{n-2}| > y_2$ then y_{n-1} and y_{n-2} give a maximum M .

Now, one needs to compare y_2 , y_3 with y_2 and y_k . One excludes y_2 and y_3 if $y_2^2 + y_3^2 + (y_2 + y_3)^2 / (n-2) > y_2^2 + y_k^2 + (y_2 + y_k)^2 / (n-2)$ or

$$(n-2)(y_3^2 - y_k^2) > (y_2 + y_k)^2 - (y_2 + y_3)^2$$

$$= (y_k - y_3)(2y_2 + y_3 + y_k)$$

$(n-2)(y_3 + y_k) > -(2y_2 + y_3 + y_k)$ since $y_3 - y_k$ is positive.

Also,

$$2y_2 > (n-1)(-y_k - y_3).$$

Since the right hand side is maximum when $k = n-1$, one needs to test y_2 , y_3 with y_2 and y_{n-1} and rule 3 is proved.

Similarly, rule 4 may be proved and in fact among combinations of m means, one would exclude the one containing y_i instead of y_{i+j} if $2Y > (m+1)(-y_i - y_{i+j})$ and exclude y_{i+j} instead of y_i , otherwise. Here Y = the sum of all $m-1$ values of the y 's excluded.

Example: From the 9 ranked means 205, 200, 200, 185, 143, 140, 138, 133, and 132 one wants to find the combination of 8 means (including the first and the last means) which gives the minimum sum of squares. Coding by subtracting 164, the mean of 9 means, one obtains 41, 36, 36, 21, -21, -24, -26, -31, and -32 as y_1 , y_2 , ..., y_9 . $\sum_1^9 y_i^2 = 8392 = S$.

Since $y_2 > |y_8|$, the sums of squares among the 8 means excluding y_2 , y_3 , y_4 , y_5 , y_6 , y_7 , y_8 or y_7 , y_8 , gives the minimum sum of squares among any 8 means and $S - y_2^2 - y_2^2 / (n-1) = 6934$.

Among the sums of squares of 7 means one should exclude either y_2 , y_3 ; y_2 , y_8 or y_7 , y_8 . Since y_2 and y_3 are both greater than y_7 , y_8 , it is obvious that one should exclude y_2 , y_3 , and the minimum sum of

squares among 7 means is $ss_{1456789} = S - y_2^2 - y_3^2 - (y_2 + y_3)^2/(n-2) = 5059.$

To get the minimum sum of squares among 6 means one should exclude either (1) y_2, y_3, y_4 ; (2) y_2, y_3, y_8 ; (3) y_2, y_7, y_8 ; or (4) y_6, y_7, y_8 . Now, $2(y_2 + y_3) > (6+1)(-y_4 - y_8)$. Therefore, if the values in (1) are excluded one gets a smaller sum of squares than if the values in (2) are excluded. Since $2(y_2 + y_8) > (6+1)(-y_3 - y_7)$ the values in (2) are excluded instead of the values in (3). Similarly, (4) is preferable over (3). One needs only to compare (1) with (4).

$$\begin{aligned} y_2^2 + y_3^2 + y_4^2 + (y_2 + y_3 + y_4)^2/(n-3) &= 4475 > y_6^2 + y_7^2 + y_8^2 \\ &\quad + (y_6 + y_7 + y_8)^2/(n-3) = 3307. \end{aligned}$$

Therefore, excluding y_2, y_3, y_4 one gets the minimum sum of squares, $as_{156789} = 8392 - 4475 = 3917$.

REFERENCE

¹ DUNCAN, D. B. — A Significance Test for Differences Between Ranked Treatments in an Analysis of Variance, *Virginia Journal of Science*, 2: 172-189.

News and Notes

(EDITOR'S NOTE: *News contributions should be sent to the person whose name appears at the end of the appropriate section.*)

A MESSAGE TO THE MEMBERS FROM THE PRESIDENT

The time is now propitious for scientists in Virginia to make significant contributions to knowledge. Because of our agricultural background and because of a half-century of impoverishment after the Civil War, it was extremely difficult for Virginia in the past to develop great centers of scientific scholarship. Only those who lived through this period could appreciate the difficulties which had to be overcome.

The situation has now changed and there are many reasons for this change. One of the most important of these is the part played by the Virginia Academy of Science. During the past thirty years the Academy, through such tireless leaders as J. Shelton Horsley, Sr., Wirtley Rudd, and E. C. L. Miller, has done much background work to arouse a genuine interest in science and to create "the will to do" on its behalf.

The background work has been done, however, and the stage is now set for Virginia to win a position of real scientific leadership in the nation. There is only one way by which a region can accomplish this, and that is the hard way of actually making distinguished contributions to scientific knowledge. The discovery of new scientific knowledge must be the spearhead of our scientific activity. The potentialities of the future lie largely in the undiscovered laws of nature all around us.

Most people in Virginia must participate in scientific research. Original scientific investigations should be carried out in our high schools and in our small colleges, at least by the members of the faculty. Dalton, the father of the atomic theory, and Henry the co-discoverer of the laws of electromagnetic induction, were teachers in elementary schools. The discovery of new knowledge is the heart of education. Everyone interested in science can carry out an independent investigation about some phase of nature which interests him. There are enough problems to go around, and it is amazing what a source of pleasure and real accomplishment these modest investigations can be.

Not only should there be a great increase in the number of people who are conducting original investigations in science but the quality of research in our institutions of higher learning and in our industrial laboratories should be greatly improved. We must select problems worthy of our best effort. There must be centers of distinguished scientific scholarship in our entrancing valley of Virginia, in our rolling Piedmont, and in our gracious and historic Tidewater. Such centers must enhance and not deface the great beauty of these regions. Let us not be faint-hearted about this objective to win true scientific leadership in this fast-moving and challenging age in which we now find ourselves.

If this leadership in science can be won, it might help generate a general rejuvenation in the intellectual and cultural leadership in Virginia. There is nothing so infectious as an example of discovery. Let discovery then be the order of the day in Virginia. This will be the keynote of the annual meeting of the Academy at the University of Virginia in May of 1954.

RESEARCH COMMITTEE

Encouragement of research in Virginia has always been one of the chief objectives of the Academy. Research Grants-in-Aid, and also the annually available J. Shelton Horsley Research Award, are offered by the Academy to encourage and stimulate research work of its members. The attention of Academy members is called to the availability of both the Grants-in-Aid, and the Award. The Research Committee urges the greater interest and participation of members in both.

RESEARCH GRANTS-IN-AID

The income from the Academy's Endowment Fund is set aside each year to provide assistance to Academy members who submit to the Research Committee worthy research problems for which financial assistance is needed. Research grants have varied in amount but during recent years have averaged approximately \$100.00 each.

Applicants for Research Grants are requested to outline the proposed problem, and list the items for which assistance is required. The names and addresses of three persons who know his qualifications for scientific research should be submitted with the request.

J. SHELTON HORSLEY RESEARCH AWARD

Members of the Academy and officers of Sections are requested to give thought to the entering of papers for the 1954 Horsley Research Award. In recent years the only requirements for eligibility for the J. Shelton Horsley Research Award have been that submitted papers should (1) present original research (2) by Academy members (3) at the annual May meeting, — (4) the paper dealing either with unpublished data or be a published work — if publication had not been prior to May of the previous year. Published papers may be entered as reprints. It is recommended that unpublished manuscripts be suitable in content and length for publication in a recognized scientific journal.

It is anticipated that essentially the same rules will apply to eligibility in 1954. Details of these will be worked out by the Research Committee and will be supplied to every member by the secretaries of the various Sections with their calls for papers for the May meeting. Members desiring details of eligibility before receiving the secretaries' call for papers will be furnished with this information on inquiry to the Research Committee.

The Horsley Award is one of the top prizes available to scientists in Virginia. The widespread interest and participation of members in the seeking of this award will mark a healthy condition with respect to the type of research work being carried out in the state. Such interest and participation is desired and solicited. — W. S. FLORY, *The Blandy Experiment Farm, University of Virginia, Boyce, Virginia.*

COMMITTEE ON LOCAL ARRANGEMENTS

For the Virginia Academy of Science Meeting, May 6-7-8, 1954

F. W. Young	General Chairman
Cobb Chemical Laboratory University, Virginia	
Otis L. Updike	Housing
Dept. of Engineering University, Virginia	
Edwin E. Floyd	Registration and Information
Paul M. Gross	Traffic and Parking
Richard H. Henneman	Signs and Maps
Edwin W. Pullen	Junior Academy Exhibits
Dept. of Anatomy University Hospital Charlottesville, Virginia	
James W. Cole	Commercial Exhibits
Cobb Chemical Laboratory University, Virginia	
Kenneth R. Lawless	Meeting Rooms and Equipment
Joseph K. Roberts	Geology Field Trip
Horton H. Hobbs	Biology Field Trip
Russell J. Rowlett	Publicity and News
Research Laboratories Virginia-Carolina Chemical Corp. Richmond, Virginia	
Mrs. A. T. Gwathmey	Entertainment for Ladies

Any inquiries not covered by the above committees should be addressed to F. W. Young, General Chairman.

NOTICE TO SECTION SECRETARIES

Concerning the Virginia Academy of Science Meetings May 6, 7, 8, 1954

The secretaries of the sections must have all material for the program by March 7, in the hands of the Editor-in-Chief, Boyd Harshbarger, Department of Statistics, Virginia Polytechnic Institute, Blacksburg, Va.

SECTION NEWS

AGRICULTURAL SCIENCE SECTION

Dr. Walter S. Flory presented the dedicatory address when the new \$425,000 Science Hall at Bridgewater College was dedicated on June 1, 1953. His address was entitled "Basic Science and Applied Science — The Contributions of the Liberal Arts College to These Fields." Two honorary Sc. D. degrees were awarded at Bridgewater College at its June 1 commencement: one to Dr. Robert Burns, Professor of Biology at Johns Hopkins University, and the other to Dr. Walter S. Flory, Professor of Experimental Horticulture, The Blandy Experimental Farm, University of Virginia, Boyce, Virginia.

October visitors at The Blandy Experimental Farm included (1) Len Woefle of Cincinnati and (2) F. G. Meyer of St. Louis. Mr. Woefle is Chairman of the Pancratiae Committee of the American Plant Life Society, and was interested in the rather extensive collection of plants of this tribe — particularly of species of Hymenocallis (the spider lilies) — at the farm. Dr. Meyer, Dendrologist for The Missouri Botanical Garden, went over many of the woody species in The Blandy Farm Arboretum.

R. B. Hall resigned as Assistant Soils Technologist at the Virginia Truck Experiment Station, Norfolk, effective November 15, to accept a position with the American Agricultural Chemical Company.

Dr. Peter L. Henderson has been appointed Associate Professor of Marketing in the Department of Agricultural Economics at Virginia Polytechnic Institute. His work will be in the field of marketing fruits and vegetables. Dr. Henderson is a native of Gordon County, Georgia. He received his Bachelor of Science and Master of Science degrees in Agricultural Economics from the University of Georgia, and his Ph.D. degree in Marketing from Cornell University.

Mr. B. F. Morgan has resigned his position as Extension Milk Marketing Specialist to accept employment as General Manager in the Tri-State Milk Producers Association with headquarters in Bristol, Virginia.

Dr. John T. Buck, Research Poultry Marketing Specialist, Virginia Polytechnic Institute, presented findings of recent research on broiler financing and marketing methods in Virginia before the Virginia Feed Association Convention in Richmond, October 14. Dealing with the factors involved in broiler contracting, his topic was "Is Broiler Financing A Good Deal For Feed Dealers?" Importance of credit to growth of the broiler industry was emphasized and the necessity of wise selection of individual growers to receive credit.

Mr. Maynard C. Conner, Associate Agricultural Economist in Dairy Marketing, presented a paper entitled, "Applying Results of Model Plant Analysis" at the 46th Annual Convention of the Milk Industry Foundation in Boston October 26-28. This discussion was based on a current research project for analyzing dairy plant costs.

Mr. W. W. Lewis, Extension Agronomist at Virginia Polytechnic Institute, is away on leave of absence doing graduate work in Agronomy at the University of Maryland, College Park, Maryland. Mr. Lewis left in September and will be back in February. He is specializing in Plant Breeding and Plant Physiology.

The Department of Agronomy, Virginia Polytechnic Institute, has just received a grant from the Pacific Coast Borax Company to help defray cost of studies in the use of boron on agronomic crops as it affects quality.

A soil survey of Fairfax County, Virginia, was inaugurated on July 1, in response to various county groups, including the firm McHugh and McCrosky who are working out a county plan for the development of Fairfax County. In view of the fact that this survey is to be used largely as a basis for urban development, the county is bearing a portion of the cost. This is the first time in the State of Virginia that a survey has been directed primarily toward a use other than agricultural.

Dr. Walter Leo Griffeth, who completed his Ph.D. degree at Michigan State College, is now Associate Agronomist at the Northern Virginia Pasture Research Station, Middleburg, Virginia. This position was vacated by Dr. Willis Skrdla, who is employed as a turf specialist with the Tactical Air Force at Langley Field, Virginia.

Ralph S. Westing, former Assistant County Agent in Augusta County, has been appointed Assistant Extension Animal Husbandman in charge of swine, to replace George C. Herring, now Assistant Director of Extension.

D. B. Allen, Associate Professor of Animal Husbandry, resigned.

R. C. Carter, Professor of Animal Husbandry with Experiment Station, completed all course work for his Ph.D. at Ames, Iowa, and will return for the winter quarter to complete his dissertation.

W. N. Patterson was appointed Associate Professor of Dairy Husbandry, Virginia Polytechnic Institute, effective August 1, 1953. Professor Patterson obtained his B.S. and M.S. degrees from the University of Wisconsin. At Virginia Polytechnic Institute he will be in charge of the 4-H Dairy Club projects of the Virginia Agricultural Extension Service.

N. R. Thompson returned from leave of absence for graduate study at North Carolina State College and Michigan State College July 1, 1953. He is now Associate Professor of Dairy Husbandry at Virginia Polytechnic Institute, and devotes his full time to dairy research projects.

Professor E. J. Finnegan assumed his duties as Associate Professor of Dairy Husbandry at Virginia Polytechnic Institute September 1, 1953. He

filled the position left vacant by the death of Dr. C. C. Flora. Professor Finnegan will have charge of the Dairy Processing Plant and teach courses dealing with dairy manufacturing. He received his B.S. and M.S. degrees from the University of Massachusetts.

Dr. Flood S. Andrews, Associate Professor in the Department of Horticulture at Virginia Polytechnic Institute, returned from a two-year leave of absence spent in Bolivia on the U. S. Point Four Program. Dr. Andrews will spend approximately two-thirds of his time on research in connection with the production of vegetable crops and one-third in teaching.

Henk Van de Werken has been appointed Instructor in Horticulture at Virginia Polytechnic Institute. Mr. Van de Werken received his horticultural training at the General Horticultural School at Frederiksoord, Holland. His work will be in connection with the research program in floriculture and nursery management.

J. O. Nicholson was advanced from the position of Plant Propagator to the classification of Instructor in the Department of Horticulture at Virginia Polytechnic Institute.

Mr. Lawrence I. Miller, Associate Professor of Plant Pathology, Virginia Agricultural Experiment Station, located at the Tidewater Field Station, Holland, Virginia, was awarded the Ph.D. degree in plant pathology by the University of Minnesota in April, 1953.

WESLEY P. JUDKINS, *Virginia Polytechnic Institute*

SECTION OF ASTRONOMY, MATHEMATICS AND PHYSICS

O. F. Schuette, Jr., Professor of Physics at William and Mary, has received a year's leave of absence to do research in Germany under a Fulbright grant. Professor Gordon L. Vandervort of the University of Wisconsin will be at William and Mary for the year.

Walter M. Miller has joined the Mathematics faculty of Roanoke College. He was formerly on the staff at Washington and Lee.

Professor T. A. Botts, University of Virginia mathematician, has received a grant from the Fund for the Advancement of Education and is spending the year in study and research at the University of Virginia and at the University of Chicago.

Assistant Professor R. W. Royston has returned to the Department of Mathematics of Washington and Lee University after a two-year leave of absence which he spent at the University of Michigan.

Dr. Reuben E. Alley, Jr. has returned to the Physics staff at the University of Richmond as Associate Professor of Physics. For the past two years Dr. Alley has been on the Technical Staff of Bell Laboratories. Mr. A. E. Williamson, formerly at the University of Richmond, has joined the staff of the Southern Research Institute.

Dr. John S. Plaskett has been appointed Acting Assistant Professor of Physics at the University of Virginia. Dr. Plaskett is a native of Great

Britain and was at the Universities of London and Bristol before coming to Rouss Physical Laboratory.

Professor W. L. Archibald of Dalhousie University is spending his sabbatical leave at Rouss Physical Laboratory. Professor Archibald is an authority on the settling of substances in gravitational and centrifugal fields.

Dr. J. W. Sawyer and Mrs. Marion J. Stokes have joined the Department of Mathematics at the University of Richmond as Associate Professor and Instructor respectively.

Dr. J. W. Beams has been appointed the Francis H. Smith Professor of Physics at the University of Virginia.

Dr. Richard Garrett, recent graduate of the University of Virginia, has joined the faculty of Hollins College as Assistant Professor of Physics. He will teach courses in Astronomy as well as in Physics.

Professor Worth J. Young of the Physics staff at Emory and Henry spent the summer in study at Harvard University as the recipient of a Peabody Scholarship.

Members of the Academy will welcome the return of Dr. Fred Allison to Virginia. Dr. Allison recently retired after thirty years service as Head of the Physics Department and Dean of the Graduate School at Alabama Polytechnic Institute. He has accepted an invitation to return to Emory and Henry College as Professor of Physics and Mathematics. Professor Allison began his teaching career at Emory and Henry forty years ago and at that time personally solicited the funds required to construct the Creed Fulton Memorial Building, a combined physics laboratory and observatory.

The Department of Physics of the University of Richmond, in cooperation with the Medical College of Virginia Radiation Laboratory, conducted an indoctrination and training program for Radiological Monitoring Teams this past spring.

Drs. Harold Alden and Alexander Vyssotsky of McCormick Observatory, University of Virginia, were participants in the recent Conference on Astrometric Problems held at Northwestern University.

A group of women's colleges, of which Hollins College is a member, are interested in sponsoring a conference on "The Role of Women in the Physical Sciences." The purpose of the Conference is to explore means of improving the education of women in science and the placing of these women in teaching and research positions. The cooperation of all industries and women's colleges is urgently desired and suggestions will be welcomed.

Professor G. W. Burns, Department of Physics of Mary Washington College, has recently been granted a patent on a combination Household-Clinical Thermometer. It is essentially an ordinary thermometer bent into the form of an L. Professor Burns hopes that it may be used as a clinical thermometer, but can be sold at a much cheaper price than those now used.

Dr. Mary Ann Lee, Chairman of the Department of Mathematics at Sweetbriar College, has been granted a sabbatical leave. She will be at the Naval Air Missile Station. Replacing her is Miss Eleanor Palmer, Instructor in Mathematics.

Randolph-Macon College was host recently at a Scholar's Convocation on the occasion of the formal dedication of Smithey Hall, the new physics and mathematics building. The new building was named for Dr. Royal Bascomb Smithey who retired in 1917 after forty years of service to the College. The convocation was highlighted by speeches by Dr. Gillie A. Larew, Emeritus Dean and Professor of Mathematics at Randolph-Macon Women's College and Dr. John A. Sauer, Chairman of the Department of Physics at Pennsylvania State College.

Friends and colleagues of Kenneth Blair Rhodes, Assistant Professor of Physics at Virginia Military Institute, were saddened by his sudden death in Pittsburgh, Pennsylvania on October 16, 1953. He had been on leave, attending the graduate school of the University of Pittsburgh for three years. At the time of his death he had completed his work for a Ph.D. in physics, and had planned to return to his post at Virginia Military Institute on November 1. He was much loved and respected by both faculty and students, and he will be greatly missed.

IRVING G. FOSTER, *Virginia Military Institute*

BIOLOGY SECTION

George K. Reid, Jr., formerly Assistant Professor of Biology at William and Mary, resigned in June to accept a position in fisheries work at Texas Agricultural and Mechanical College.

Donald H. Bucklin, Ph.D. in Zoology from Washington University and Merck Post-Doctoral Fellow at Harvard University, came to William and Mary in September as Assistant Professor of Biology. His field of research is experimental embryology; most of his work has been with the grasshopper.

Herman Silva Forest, Ph.D. in Botany from Michigan State College, has been appointed Acting Assistant Professor of Biology at William and Mary. His research is on the floristics of freshwater algae.

Bernard Mikula, graduate in 1952 from William and Mary, student of the Virginia flora and now a graduate student at Washington University, spent the past year abroad — chiefly at the British Museum — on a special project for the Missouri Botanical Garden and in pursuing his own researches on the systematics of certain groups of Compositae.

Miss Frances E. Silliman, Associate Professor of Biology at Bridgewater College, is on leave of absence during the session of 1953-54, and is studying at the University of North Carolina. Mr. James E. Irvine, IV, of Charlottesville, has been appointed Assistant Professor of Biology for the current session.

A modern, well equipped science hall is the most recent building to be added to the physical plant at Madison College, Harrisonburg, Virginia. The new building will house classrooms, laboratories, and stockrooms for biology, chemistry, geography and geology, and physics departments. The biology department occupies the major portion of the first floor and one-half of the second floor. On the first floor, a plant science laboratory, a general biology laboratory, a large classroom, offices, and storerooms are located. A zoology laboratory, physiology and bacteriology laboratory, a classroom, and office, and storerooms are located on the second floor. Another special feature of the department will be a green house, located at the east end of the science building, which will be used primarily for instructional purposes. A dark room with a light trap entrance will be equipped by Eastman Kodak Company. The new building will be a definite asset to the college as well as to the community.

Mr. Paul R. Burch, formerly Professor of Biology and Head of the Department at Radford College, has announced his retirement after 32 years of teaching. Mr. Burch plans to spend his time in preparing his studies of molluscs in Virginia for publication and in enlarging his extensive collection.

Mr. H. T. Cox of Virginia Polytechnic Institute is on leave of absence to serve as Deputy Executive Director of the American Institute of Biological Sciences. Mr. F. R. Burleson, M.S., Virginia Polytechnic Institute, has been appointed temporary Instructor in Botany in the absence of Mr. Cox.

Mr. G. W. Underhill retired from active service with the Virginia Agricultural Experiment Station after serving the State of Virginia for 35 years. Mr. Underhill has been succeeded by Mr. E. C. Turner, Ph.D., Cornell University, who holds the rank of Associate Entomologist.

Mr. T. B. Davich, Ph.D., University of Wisconsin, has been appointed Associate Entomologist at the Tidewater Field Station of the Virginia Agricultural Experiment Station.

Mr. Vincent Schultz, formerly of the Tennessee Game and Fish Department, has joined the staff of the Virginia Polytechnic Institute Wildlife Unit with half-time assignment to the Virginia Cooperative Wildlife Research Unit.

Mr. David V. Smith, M.S., Duke University, has been appointed Assistant Professor of Forestry at the Virginia Polytechnic Institute.

Mr. Fred S. Orcutt, Professor of Bacteriology at the Virginia Polytechnic Institute, is on leave of absence for this year and is serving as visiting Professor of Biology at the University of Hawaii.

Mr. Kendall W. King, Ph.D., University of Wisconsin, has been appointed Assistant Professor of Bacteriology at the Virginia Polytechnic Institute.

Mr. W. G. Hoag, D.V.M., Cornell University, has been appointed Professor of Animal Pathology at the Virginia Polytechnic Institute.

Mr. Jack D. Burke, Ph.D., University of Florida, and formerly Assistant Professor of Biology at Longwood College, has been appointed to the staff of the Biology Department of the University of Richmond. Mr. Burke is teaching Histology and Embryology and continuing his research on mammalian blood volumes.

Dr. Roy P. Ash, Associate Professor of Biology at the College of William and Mary and long-time member of the Virginia Academy of Science, died on July 21, 1953, in the Medical College of Virginia Hospital, after a long illness.

Roy Phillip Ash was born at Parkersburg, West Virginia, on July 11, 1907. He received the A.B. degree from Marietta College in 1930, and the M.A. and Ph.D. degrees from Brown University, the latter in 1935. In 1935 he was appointed to the College of William and Mary with the rank of Assistant Professor of Biology. In 1949 he was made Associate Professor. From 1942-1946 Dr. Ash served as First Lieutenant and Captain in the Sanitary Corps of the U. S. Army.

Doctor Ash served the Academy faithfully; in 1952 he was a member of the Local Committee on Arrangements, and had been active on other committees. He was a participant in many community affairs. As a teacher he was sound, thorough, and understanding, his courses in Comparative Anatomy and Embryology being especially outstanding.

He is survived by his wife, the former Frances Nenzel and by three sons, Roy Phillip Jr., Charles William, and Andrew Nenzel Ash, all of Williamsburg.

Mr. Robert F. Smart, Chairman of the Biology Department at the University of Richmond, has been granted a sabbatical leave beginning the second semester of this year.

Mr. H. L. Holloway, M.A., University of Richmond, has been appointed Assistant Professor of Biology at Roanoke College. He is completing his work for the Ph.D. degree from the University of Virginia *in absentia*.

ROBERT T. BRUMFIELD, *Longwood College*.

CHEMISTRY SECTION

Bridgewater College has announced the completion of its new \$425,000 Science Building, which was dedicated last June with an address by Dr.

Walter S. Flory of the University of Virginia. The three-story structure will house the departments of biology, chemistry, geology, mathematics, physics, and psychology, and has storage facilities in the basement, in addition to space for shops and a museum.

The laboratory facilities for chemistry include two faculty research laboratories and three large undergraduate laboratories, with individual desk space for 230 students. Services to the desks include water, gas, air, 110 volt AC, and variable AC-DC current. Among the new items of equipment are a spectrophotometer, Todd Spectranal, polarimeter, polarizing microscope, chainomatic analytical balances, and nuclear counting equipment.

The science departments at Madison College have also moved into a new building, Burruss Science Hall, part of which is still under construction. Completion of the entire building is not expected for several years.

Of the 1953 graduates, Janet Corbin is teaching chemistry at Waynesboro High School, and Conrad Miller has accepted a research assistantship in chemistry at Oklahoma A. and M. Harold Rhodes, also a chemistry major, has accepted an invitation from the army for temporary duty.

Staff changes at Randolph-Macon Woman's College: Dr. Nan V. Thornton, Head of the Chemistry Department, has been granted a leave of absence to do research at the University of Chicago. Dr. Helen L. Whidden, who received her doctorate last June from the University of Massachusetts, will serve as Acting Head while Miss Thornton is on leave. Dr. Esther B. Leffler, Instructor in Chemistry, has resigned to accept a position in the Chemistry Department of Sweet Briar College, while added to the Randolph-Macon staff have been Miss Helen V. Pashko as Instructor in Chemistry and Miss E. Katherine Wright as Visiting Professor of Chemistry for one year. Miss Pashko received her Master's degree last June from Wesleyan University, Middletown, Conn., and Miss Wright has taught for a number of years at American College, Istanbul, Turkey; last year she served on the staff at Sweet Briar.

From Roanoke College: Judith E. Sund, a chemistry major and a Student Assistant in the Chemistry Department, has been selected to receive a James Lewis Howe Award of the Virginia Blue Ridge Section, A.C.S., for the best "all around" chemistry major at Roanoke College. These awards are made annually by the Blue Ridge Section to an outstanding major in chemistry and chemical engineering in each of the schools of the Section area granting baccalaureate degrees in these fields.

From the University of Richmond: Dr. W. Allan Powell, Assistant Professor of Analytical Chemistry, received his doctorate last June from Duke University. Material from his dissertation was published (with J. H. Saylor) in the June, 1953 issue of *Analytical Chemistry* under the title of "Fluorometric Determination of Small Amounts of Fluoride." Dr. Thomas H. Franklin, with Ray Sothern, presented a paper at the recent American Chemical Society Meeting in Chicago entitled, "The Competitive Adsorption from Aqueous Solutions of Hydrogen and Nitriles on Platinized Platinum." The entire chemistry staff attended the meeting.

Recipients of the M.S. degrees this fall were Ray Sothern and Clayton C. Roth. Mr. Sothern is now doing graduate work in chemistry at Johns Hopkins University and Mr. Roth is now employed with the du Pont Company in Richmond. Mr. Roth is also the first student to receive a Master's degree under the night graduate program. While working full time in local industries he completed the degree requirements within three years.

New graduate students at the University of Richmond this year are Samuel L. Cooke, Phillip L. Oglesby, Emmett H. Poindexter, Jr., all graduates of Richmond, and Charles J. Hansrote, Jr. (Virginia Military Academy), James E. Hardcastle (William and Mary), and Walter J. Triner, Jr. (Moravian College).

Dr. Alfred Burger of the University of Virginia staff was awarded in Paris last summer the Pasteur Silver Medal in recognition of his work in medicinal chemistry. Dr. Burger is also the new chairman of the Division of Medicinal Chemistry of the American Chemical Society.

Dr. Robert E. Lutz has resigned as temporary chairman of the Chemistry Department of the University of Virginia, and the position is being filled by Dr. John H. Yoe, Professor of Chemistry. Dr. Ralph E. Thiers has been granted a leave of absence for the current session and is doing research at the Peter Bent Brigham Hospital of the Harvard Medical School. Dr. John S. Belew has joined the staff as Acting Assistant Professor of Chemistry.

Dr. Robert H. Kean of the Virginia-Carolina Chemical Corporation, Richmond, has been promoted from Assistant Director of Research to Director of Development. Mr. George J. Allen, senior chemical engineer with the Research Department, has been transferred from Charleston, S. C., to Richmond, where he will be in charge of a pilot and process development unit now under construction.

New members added to the Virginia-Carolina research staff since July, 1953, are Matthias F. Kelley, Jr., Brenton S. Halsey, Miss Peggy Jane Harrison, and Mrs. Anne Mays Magnusal. Mr. Kelley joined the department as organic chemist after graduate study at the University of Virginia and has served two years with the navy. Miss Harrison received her Bachelor's degree in chemistry from Mary Washington College last June and is now a research technician with the Fiber Group. Mrs. Magnusal, formerly with the Division of Plant Industry of the State Department of Agriculture, is now a research technician with the Biological Group; she received her Bachelor's degree in biology from Radford College.

Herschel S. Jenkins, Fiber Section Leader at the Virginia-Carolina Chemical Corporation, is writing the section on synthetic protein fibers in the "Encyclopedia of Chemical Technology," Volume 11, to be published by Interscience in the Spring of 1954.

News items from Virginia Military Institute: Dr. C. W. Smart has been promoted to Associate Professor of Chemistry. A. L. Lawrence and R. C. White have been added to the staff as Instructors in Chemistry.

Major George M. Pickral received his doctorate last June from the University of Cincinnati.

Faculty changes at Washington and Lee: Dr. John H. Wise added to the chemistry staff as an Associate Professor and Dr. James K. Shillington as an Assistant Professor. Dr. Wise is a graduate of Haverford College and took his doctorate in physical chemistry at Brown University. He formerly taught at Stanford University. Dr. Shillington is a graduate of Iowa State College and received his Doctor's degree in organic chemistry from Cornell. He comes to Washington and Lee from Amherst College.

Dr. E. S. McKee, who was with the Washington and Lee Department last year, has returned to industry, having accepted a position with the Catalyst Research Company of Baltimore.

Recent additions to the chemistry staff at Virginia Polytechnic Institute are Dr. David W. Levi as Assistant Professor and Mr. Edward C. Kramer, Jr. as Instructor in Chemistry. Dr. Levi is a graduate of Randolph-Macon and received both his Master's and Doctor's degrees from Virginia Polytechnic Institute, his research work being in the field of high polymers under the direction of Dr. P. C. Scherer. Mr. Kramer received his Bachelor's degree from Wagner College, New York, and is pursuing graduate work at Virginia Polytechnic Institute. During the 1952-53 session he served as research assistant in the department under Dr. F. A. Vingiello.

Mr. W. B. Howsmon, formerly Instructor in Chemistry at Virginia Polytechnic Institute, has returned to Purdue University for work on his doctorate degree.

New graduate teaching assistants at Virginia Polytechnic Institute this year are Peter E. Newallis, B.S. and M.S., Marshall College, West Virginia, and James C. Salonish, B.S., University of Pittsburgh. C. W. Bondurant, Jr., B.S., Emory and Henry College, M.S., Virginia Polytechnic Institute, and C. F. Epes, Jr., B.S., Virginia Polytechnic Institute, are new research assistants working under Dr. P. C. Scherer. George B. Tichelaar, B.S. and M.S., DePaul University, Chicago, and Teh-fu-Yen, M.S., University of West Virginia, are new research assistants working under Dr. Robert C. Krug.

Dr. R. C. Krug has been awarded a research contract by the Air Research and Development Command, Baltimore, relating to the preparation of conjugated alkadienes. Dr. P. C. Scherer's Army Ordnance Research Contract has been enlarged for the current year to include a study of dielectric dispersion in polymer solutions.

The sixth paper of a series on the mechanical properties of high polymers has been published by Philip C. Scherer (with James E. Johnson) in the June-August, 1953, issue of *Modern Textile Magazine*.

Dr. J. W. Watson and Dr. F. B. Clough represented the Virginia Polytechnic Institute Chemistry Department at the A. C. S. meeting held in Chicago in September. Dr. Watson is the Councilor for the Blue Ridge Section of the American Chemical Society.

CARL J. LIKES, *Virginia Institute For Scientific Research*

ENGINEERING SECTION

Professor Nelson F. Murphy of the Department of Chemical Engineering, Virginia Polytechnic Institute, attended the annual meeting of the Electrochemical Society at Wrightsville Beach, North Carolina, September 14-16, 1953. He attended a chemical seminar in Pittsburgh, Pennsylvania on October 9, 1953, where he presented a paper entitled "Modern Aspects of Corrosion Theory".

Professor F. C. Vilbrandt of the Department of Chemical Engineering, has been appointed counsel member representing Virginia Polytechnic Institute on the Oak Ridge Institute of Nuclear Study and is acting on the management committee of the Oak Ridge Institute. He attended a meeting of the management committee on October 2, 1953 at Oak Ridge.

Mr. Tilton E. Shelburne, Director of Research, Virginia Council of Highway Investigation and Research, presented a paper on the "Virginia Highway Research Program" at the Florida Highway Conference sponsored by the University of Florida in Gainesville in November, 1953.

GEOLOGY SECTION

The Department of Geology at the University of Virginia has recently received appropriation to purchase a Weissenberg X-ray camera and a two-circle optical goniometer. The addition of these instruments to the department's X-ray analysis laboratory will greatly expand the use of X-rays in problems related to minerals. In the future the department will be equipped not only to do X-ray analysis on powdered materials, as it has in the past, but also to do more detailed analyses using the single crystal methods. The Weissenberg camera will be useful in the identification of crystals, and it can be used to determine crystal unit cell constants, space groups, and ultimately, the atomic positions. The optical goniometer will serve a dual purpose. It will be used to orient crystals before they are X-rayed by the Weissenberg camera, and it will also be used in detailed studies of the morphology of crystals. In many cases crystals can be identified in a few minutes using only the optical goniometer. Research problems and courses involving these advanced techniques are being planned.

The Geology Department at Virginia Polytechnic Institute has been authorized by the State Board of Education to offer the Ph.D. degree and at present two students are working on their doctorates. The department is also pleased to announce that the Virginia Polytechnic Institute Library has been designated as an official repository for all publications of the U. S. Geological Survey.

Camp Holden, the department's field station at Saltville, Virginia, completed its second year of successful operation under the supervision of Dr. W. E. Moore. Students taking instruction represented four schools from three different states.

Five petrographic and two ore microscopes, recently purchased from the American Optical Co., complete the outfitting of a new petrographic laboratory — one of the finest in the country. Recent acquisitions to the department's geophysical equipment include a Hotchkiss superdip, an Askania torsion balance, a seismic prospecting truck, a Gish-Rooney type geohmeter, and a geoscope resistivity outfit.

Several earth resistivity surveys in southwestern Virginia have been made this past fall by Dr. C. E. Sears, Jr. Other studies underway include geologic mapping of Floyd Co. in the Blue Ridge, by Dr. R. V. Dietrich; a survey of the iron deposits in the Clifton Forge area by Frank Lesure, Virginia Polytechnic Institute, 1951, and National Research Council Fellow now studying at Yale University; and a continuation of research on Virginia stone aggregates — a joint project with the Virginia Polytechnic Institute Applied Mechanics Department.

Two bulletins of geologic interest have been published recently by the Virginia Engineering Experiment Station. One deals with Virginia minerals and rocks and is designed primarily to aid the beginning collector or interested layman. Both publications were prepared by Dr. Dietrich. These bulletins, along with the earlier published Virginia Mineral Resources Map, prepared by Dr. B. N. Cooper and Dr. Dietrich, may be purchased for nominal amounts from the Virginia Engineering Experiment Station, Blacksburg, Virginia. The results of a study of the silica sand resources of western Virginia made by Dr. W. D. Lowry will appear in the near future as a bulletin of the Virginia Engineering Experiment Station.

The first issue of a *Mineral Industries Newsletter* has been published by the Virginia Engineering Experiment Station. The *Newsletter*, which will appear periodically, will contain information about minerals and rocks, discussion of topics of general interest to the industry, and technical articles by guest contributors and members of the Virginia Polytechnic Institute faculty, as well as information about the departments of Ceramic Engineering, Geology, Metallurgical Engineering, and Mining Engineering.

PSYCHOLOGY SECTION

Attending a two-day conference on Psychological Resources in the South, held at the Atlanta Biltmore Hotel in July, were Stanley B. Williams, Chairman of the Psychology Section, and Frank A. Geldard of the University of Virginia. This conference was under the sponsorship of the Southern Regional Education Board. The conference resulted in the formation of a permanent organization of representatives of psychology departments in southern institutions which give graduate training. Mr. Williams was assigned to the membership committee of the new organization; it is hoped that the new committee can assess the educational and professional needs and resources of the region and make plans for improvements.

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The following recent personnel changes are reported from the Lynchburg State Colony. Miss Marianne E. Kornfeld left the employ of the Colony in September as a result of receiving an award from the International Institute of Education for study at the University of Zurich. Miss Virginia E. Schoen, who completed her internship at the Colony in October, left to take a position as Psychologist I at Toledo State Hospital. Two new psychologists are on the staff of the Colony. Mr. Eugene D. Alexander of Canisteo, New York, who has done graduate work at Merrill-Palmer and Wayne University in Detroit, and the University of Connecticut, joined the staff as Associate Psychologist in October. He holds an M.A. degree from the University of Connecticut. Mr. John H. Mendenhall assumed the position of Senior Associate Psychologist on November 2. He has done graduate work at the University of North Carolina and has taken summer courses at the New School for Social Research in New York.

Following up the suggestion of Dr. Gilbert J. Rich, there has been established an informal organization of psychologists from the three cities, Lynchburg, Roanoke, and Lexington. Serving as a steering committee are Dr. Rich, Mrs. William MacConnell and Mr. William M. Hinton. Professor L. L. Thurstone spoke at the organizational meeting in Roanoke in May. Mr. John Buck talked on the H-T-P Test at the October meeting, held in Lynchburg.

Mr. John L. McBride, M.A. from Temple University, has joined the staff at Eastern State Hospital, replacing Mr. Jason Z. Edelstein, who has entered Union Theological Seminary in Cincinnati.

Several changes in the staff in Psychology at the University of Virginia have taken place this semester as a result of a year's leave of absence taken by Mr. Frank W. Finger. Mr. Finger is spending the major portion of the current session at Yale University on a Ford Foundation Fellowship and will participate in seminars on methods in the teaching of Psychology. At least part of the year will be spent in traveling to larger institutions in the East and Midwest observing techniques in teaching Psychology at those institutions. At New Haven, Mr. Finger will also be working on a joint research project with Professor Frank Beach in the field of physiological psychology. The new appointments to the staff at the University of Virginia are those of Mr. John Paul Nafe and Mr. Evan G. Pattishall. Mr. Nafe is Visiting Professor of Psychology at the University of Virginia for the 1953-1954 session. Professor Nafe was formerly Chairman of the Department of Psychology at Washington University, St. Louis, and following his retirement last February taught for one semester at Florida State College. Mr. Pattishall, with the title of Acting Assistant Professor of Psychology, is conducting an undergraduate course in social psychology. He comes to Virginia as a Ph.D. from the University of Michigan and was formerly with the Psychological Sciences Division, Office of Naval Research, Washington.

Of interest to the members of the Psychology Section is the report that National Science Foundation Fellowships are again available to students

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in the field of experimental psychology. In previous years it was necessary for candidates to stand a competitive examination in some scientific field related to psychology, and this year for the first time a specific examination in experimental psychology is being prepared. Notices describing these fellowships are now out. Mr. Frank A. Geldard has been appointed as a member of the Committee of Biological and Medical Sciences of the National Science Foundation, and representative in the field of Psycho-biology on this Committee.

RICHARD H. HENNEMAN, *University of Virginia.*

STATISTICS SECTION

Cooperative Graduate Summer Sessions in Statistics. — Beginning in 1954 North Carolina State College, the University of Florida, Virginia Polytechnic Institute, and the Southern Regional Education Board will jointly sponsor cooperative Graduate Summer Sessions in Statistics.

The first session will be conducted by a distinguished faculty at Virginia Polytechnic Institute in the summer of 1954. Additional summer sessions are tentatively planned for North Carolina State College and the University of Florida in the two following years. Subsequent sessions will be rotated among these or other institutions throughout the South.

The summer sessions are designed to carry out a recommendation of the Southern Regional Education Board's Commission on Statistics, on which the three institutions initiating the program are represented. They will be of particular interest to (1) research and professional workers who want intensive instruction in basic statistical concepts and who wish to learn modern statistical methodology; (2) teachers of elementary statistical courses who want some formal training in modern statistics; (3) prospective candidates for graduate degrees in statistics; (4) graduate students in other fields who desire supporting work in statistics; and (5) professional statisticians who wish to keep informed of advanced specialized theory and methods.

Each of the summer sessions will last six weeks and each course will carry three semester hours of graduate credit, with a maximum of six semester hour credits earned in one summer. The courses are arranged to enable the person to take consecutive work in successive summers. The summer work in statistics may be applied at any one of the cooperating institutions in partial fulfillment of the requirements for a Master's degree. The catalog requirements for the degree must be met at the degree-granting institutions. Each Doctoral candidate should consult with the institution from which he desires to obtain the degree regarding the applicability of the summer courses in statistics.

During the first session Professor Maurice Kendall of the University of London will give a course in Multi-variate Analysis, and Dr. Ralph Comstock of North Carolina State College will give one in Quantitative Genetics.

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The staff of the Virginia Polytechnic Institute's Department of Statistics will offer such courses as Probability and Inference, Analysis of Variance, Statistical Methods, Engineering Statistics, Education Statistics, Rank Order Statistics and the Theory of Sequential Methods.

The department includes R. A. Bradley, D. B. Duncan, M. C. K. Tweedie, P. M. Somerville, and Boyd Harshbarger. In addition, other outstanding statistical scholars will direct special afternoon seminars. The agricultural, science, and engineering divisions of the College will make available advanced courses for students who wish to supplement their work in statistics.

The Virginia Polytechnic Institute is located at Blacksburg in the scenic Allegheny Mountains. The summer climate is delightful.

The fee for the Virginia Polytechnic Institute session is \$30.00. Board, room, post office box and laundry for the entire session may be had for \$76.40. The session will run from June 9 through July 17, 1954.

Inquiries should be addressed to Boyd Harshbarger, Head, Department of Statistics, Virginia Polytechnic Institute, Blacksburg, Virginia.

William A. Thompson has been appointed Associate Professor of Statistics at the Virginia Polytechnic Institute and will devote his time to research under contract with the Army Quartermaster Corps. Mr. Thompson comes from Chicago and did his undergraduate work in mathematics at the University of Illinois. His graduate work has been done at the University of North Carolina. Research for his dissertation has been conducted on a class of all statistics whose distributions are independent of nuisance parameters, and he is applying this theory to the general incomplete block variance component models to find a class of statistics whose distributions depend only on the ratio of two variances involved.

Dr. Boyd Harshbarger has given an invited talk on the application of statistical methods to analytical problems before the Conference on Analytical Methodology of the Eastern Regional Research Laboratory, Bureau of Agricultural and Industrial Chemistry of the U. S. Department of Agriculture, in Philadelphia on October 20, 1953.

Dr. David B. Duncan of the Virginia Polytechnic Institute has been invited to address the Regional Conference of the American Society for Quality Control to be held February 5-6, 1954, in Baltimore. The title of his talk will be "Student t and F test." He has also been invited to give an address at the Annual Meeting of the Highway Research Board in Washington on January 12, 1954. The title of this talk will be, "Use of Statistics in the Design and Analysis of Highway Research Projects."

Dr. Ralph A. Bradley of the Virginia Polytechnic Institute has been invited to address the Regional Conference of the American Society of Quality Control to be held February 5-6, 1954, in Baltimore. The title of his talk will be, "Some Comments on the Theory and Application of Rank Order Statistics." He has also been invited to address the American Society of Quality Control in Rochester, N. Y. on February 16, 1954. The title of this talk will be, "Application of Paired Comparisons in Qual-

ity Control." Dr. Bradley has also been reappointed chairman of the program committee for the Eastern Region of I. M. S. for 1954.

The Department of Statistics and Statistical Laboratory of Virginia Polytechnic Institute has been awarded a contract with the Office of Ordnance Research, United States Army, for basic research in statistics. Dr. George L. Edgett has been appointed a visiting professor of statistics at Virginia Polytechnic Institute for the first contract period, January 1-September 1,

and will be in charge of this contract. Dr. Edgett will be on leave of absence from Queens University, Kingston, Ontario, where he is a Professor of Mathematics. Besides teaching, Dr. Edgett is the consultant statistician for the other departments of Queens University and has advised them on designing of experiments and the interpretation of results. He has also directed many M.A. theses in Mathematical Statistics and published papers on "Frequency Distributions With Given Statistics Which Are Not All Moments," and "The Irrational Number."

The contract held by the Department of Statistics and the Statistical Laboratory of the Virginia Polytechnic Institute with the Office of Ordnance Research, U.S. Army has been renewed for another year. Dr. Duncan is chief investigator on this project.

Members of the Statistical Laboratory of the Virginia Polytechnic Institute are acting as consultants on a project for sampling for market practices of livestock auction markets. This project is sponsored by the Southern Regional Livestock Market Research Technical Committee. The statistical laboratory will also analyze the data collected.

Dr. Boyd Harshbarger, Department of Statistics, of the Virginia Polytechnic Institute has been appointed Chairman for the training section of statisticians of the American Statistical Association for the 1954 meeting which will be held at Montreal, Canada, in September.

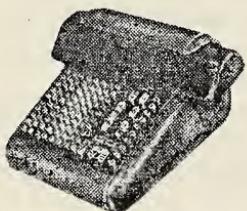
The Department of Statistics has twenty-five graduates, including men from Canada and South Africa.

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THE ANNUAL SUBSCRIPTION rate is \$3.00, and the cost of a single number, \$1.00. Reprints are available only if ordered when galley proof is returned. All orders except those involving exchanges should be addressed to Boyd Harshbarger, Virginia Polytechnic Institute, Blacksburg, Virginia. The University of Virginia Library has exclusive exchange arrangements, and communications relative to exchange should be addressed to The Librarian, Alderman Library, University of Virginia, Charlottesville, Virginia.

NOTICE TO CONTRIBUTORS

Contributions to the Journal should be addressed to Horton H. Hobbs, Jr., Miller School of Biology, University of Virginia, Charlottesville, Virginia. If any preliminary notes have been published on the subject which is submitted to the editors, a statement to that effect must accompany the manuscript.

Manuscripts must be submitted in triplicate, typewritten in double spacing on standard 8½" x 11" paper, with at least a one inch margin on all sides. Manuscripts are limited to seven pages, with the proviso that if additional pages are desired, the author may obtain them at cost.

Division of the manuscript into subheadings must follow a consistent plan, and be held to a minimum. It is desirable that a brief summary be included in all manuscripts.

Footnotes should be included in the body of the manuscript immediately following the reference, and set off by a dashed-line above and below the footnote content. Footnotes should be numbered consecutively from the beginning to the end of the manuscript.

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New Series

April, 1954

No. 2



VOL. 5

APRIL, 1954

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C O N T E N T S

	Pages
Ivey Foreman Lewis — B. F. D. RUNK	51
Nutrition, A Young Science — R. W. ENGLE	53
Observations on the Summer Behavior and Mortality of Box Turtles in Eastern Virginia — JOHN THORNTON WOOD and OLLIE KING GOODWIN	60
An Equation for Sigmoid Curves — D. S. DAVIS	65
A Rapid Slide Screening and Diagnostic Test for Newcastle Disease — MILES G. BOWLES	68
The Origin of Branching in the Aerial Shoot of <i>Psilotum nudum</i> — DAVID W. BIERHORST	72
News and Notes	79
Program of the Thirty-second Annual Meeting of the Virginia Aca- demy of Science	91

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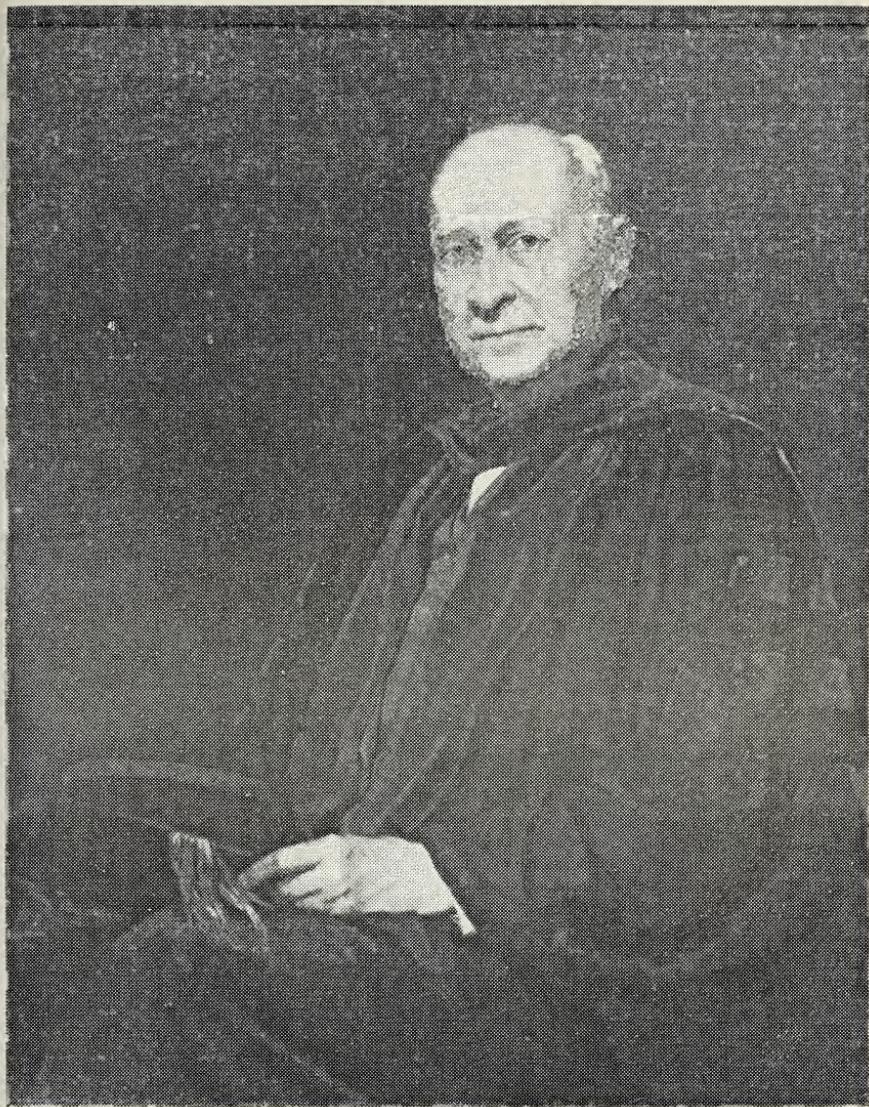
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Mailed April 20, 1954

IVEY FOREMAN LEWIS



Editor's Note: Because of the outstanding contributions made to the Virginia Academy of Science and to this Journal by Dean Lewis, this number of the Journal is dedicated to him.

THE VIRGINIA JOURNAL OF SCIENCE

VOL. 5, NEW SERIES

APRIL, 1954

No. 2

Ivey Foreman Lewis

Ivey Foreman Lewis, Miller Professor of Biology and Agriculture, Dean of the University and Dean of the College of Arts and Sciences retired from active duty on July 1, 1953.

Dean Lewis was born in Raleigh, North Carolina on August 31, 1882. His parents were from families long associated with the development and advancement of that state. His father, an alumnus of the Department of Medicine of the University of Virginia, was a physician who became a specialist in diseases of the eye, ear, nose, and throat. He was instrumental in establishing the State Board of Health of North Carolina and was in charge of the program until his retirement in 1918. His mother was Cornelia Viola Battle the first daughter of Kemp Plummer Battle who was for many years President of the University of North Carolina.

Dean Lewis received his A.B. and M.S. from the University of North Carolina and his Ph.D. in 1908 from the Johns Hopkins University. At the Johns Hopkins University Dr. Lewis received the Bruce Fellowship. Here he worked under the great botanist Duncan S. Johnson and the outstanding biologist William Keith Brooks. The Doctor of Science degree was awarded Dean Lewis by the University of North Carolina in 1947.

In 1908 Dr. Lewis studied at the University of Bonn working under the botanist Edward Strasburger. During the same year he held the Smithsonian Table at the Stazione Zoologica at Naples.

During the session of 1905-1906 and again from his return from Europe in 1908 until 1912 Dr. Lewis served as Professor of Biology at Randolph-Macon College. In 1912 he became Assistant Professor of Botany at the University of Wisconsin where he remained for two years. The academic session of 1914-1915 was spent as Professor of Botany at the University of Missouri. Upon recommendation of the Miller Board of Trustees to the University of Virginia Board of Visitors Dr. Ivey Foreman Lewis was appointed Miller Professor of Biology and Agriculture beginning in September 1915. From that date until his recent retirement Dr. Lewis has served the University in many fields of endeavor other than as Professor of Biology. In 1934 he was appointed Dean of the University, served as Director of the Mountain Lake Biological Station from 1933 to 1946 and was appointed Dean of the College of Arts and Sciences in 1946.

For many years Dean Lewis was closely associated with the Marine Biological Laboratory at Woods Hole, Massachusetts. He became instructor in Botany there in 1907, served again from 1910 to 1917, and from 1918

to 1927 was instructor in charge of the botany course. He also served as Trustee and Member of the Executive Committee of the Marine Biological Laboratory.

Dean Lewis served as a member of the National Research Council from 1928 to 1932, was a member of the Executive Committee from 1930 through 1931, Vice Chairman of the Division of Biology and Agriculture in 1931 and 1932 and Chairman of the Division of Biology and Agriculture from 1933 through 1936.

He is a trustee of Biological Abstracts, Fellow of the A.A.A.S., has served as Secretary, Vice-President and President of the Botanical Society of America, President of the American Biological Society, and President of the American Naturalists. He is a member of Phi Beta Kappa, Omicron Delta Kappa, The Raven Society of the University of Virginia, and as a member of the Society of Sigma Xi was most instrumental in having a chapter of that society established at the University of Virginia.

It was in December 1920 that Dr. Lewis founded the Association of Virginia Biologists, an organization which has been superseded by the Virginia Academy of Science. He was instrumental in organizing the latter in May 1923, and served as its first president.

The published works of Dr. Lewis are far too many to mention here. His first and most numerous publications were in algology. For his paper on "The Life History of *Griffithsia Bornetiana*" published in 1909 he was awarded the Walker Prize in Natural History by the Boston Society of Natural History. Other algal papers he considers of greatest interest are "Periodicity in *Dictyota* at Naples" published in 1910 and "*Oedocladium* in North America" published in 1921. The origin and development of plant galls has of recent years been the field of investigation receiving most of the attention of Dr. Lewis. It is hoped that in his retirement he will have more time to devote to this study.

Dean Ivey F. Lewis and his wife are now residing at their new home, "Rock Rib", Rugby Road, Charlottesville, Virginia.

B. F. D. RUNK

University of Virginia

Nutrition, A Young Science

R. W. ENGEL

*Department of Biochemistry and Nutrition
Virginia Agricultural Experiment Station*

NATURE OF THE SCIENCE OF NUTRITION

The idea that there is a close connection between the food supplied to plants or animals and their well-being is the origin of the science of nutrition. The numerous references to foods in the Bible are testimony that nutritional well-being was an utmost concern to the ancient civilizations.

In the modern sense, however, nutrition is an infant science. Only a limited number of scientists were engaged in nutrition investigations as recently as 50 years ago; no vitamins had been discovered, and the sum total of our nutrition knowledge was limited to proteins, carbohydrates, fats, and minerals. In 1930, all food companies in the United States had only about 500 research workers employed on various short-term projects in foods and nutrition. This number had risen to 2800 in 1940 and to an estimated 7000 as of today. The 14-fold increase in research effort in foods and nutrition in less than 25 years emphasizes the tremendous recent surge of interest in this young science. In 1930, only three vitamins had been synthesized, and a clear understanding of their chemical structure was known for only two of these. Today the list has grown to at least 20 organic chemical compounds that are classified as accessory food factors or vitamins, and experimental evidence indicates that there are probably several more as yet uncharacterized.

The science of nutrition depends on many related scientific disciplines. Basically, however, there are two sciences upon which nutrition is founded: biochemistry and physiology. Both of these are applied sciences in the sense that newer findings in these fields rest upon the application of new information in the foundation sciences of chemistry, physics, mathematics, and biology.

Broadly, the science of nutrition deals with the processes involved in the consumption, digestion, assimilation, and utilization of food constituents by the living organism. It becomes clear that a thorough knowledge of physiology is necessary for an understanding of nutrition principles. Present day physiologists readily submit that aside from the physical measurements widely used in physiology (gas diffusion, voltage, pressure phenomenon, etc.) all other phases of physiology rest upon biochemistry. Dr. L. A. Maynard states that nutrition is a chemical process and its principles must be presented in chemical terms.

With the exception of anatomy (the oldest of the medical sciences), physiology has traditionally maintained the position of having served as parent for all of the newer sciences that have become departmentalized with the growth of our knowledge of the function of living matter. Nutrition represents one of these younger sciences. One of the younger sciences which perhaps most nearly parallels the basic principles of nutrition is the field of pharmacology and experimental therapeutics. The American Society of Pharmacology and Experimental Therapeutics originated in 1908 and was composed of physiologists who were interested in the biological effects of chemical compounds. It is obvious that their interest closely paralleled the present-day concept of the nutritionist.

A prominent physiologist recently enumerated some great discoveries made in the past 40 years by pharmacologists. Among these were hormones, vitamins, anti-vitamins, antibiotics, toxins, acetylcholine, histamine, demerol, dicumerol, and heparin. An examination of the scientists associated with these discoveries would include such names as Baylis, Starling, Howell, Steenbock, Elvehjem, Hart, and McCollum; the first three were physiologists and the latter biochemists or agricultural chemists. If the pharmacologists claim these discoveries, then it must be admitted either that these men were pharmacologists or that the sciences in which their contributions were made are so closely allied to pharmacology that any attempt at scientific departmentalization appears futile.

Other young sciences that have developed from physiology (enzymology, cellular physiology, physiological chemistry, endocrinology, experimental pathology) are just as difficult to separate from the science of nutrition as is pharmacology.

In this country nutrition was departmentalized as a distinct science in 1928 when the American Institute of Nutrition was organized. The eight scientists who served on the Editorial Board of the *Journal of Nutrition* in that year when the first volume was published identified themselves about equally as being physiologists or chemists (physiological or agricultural). At present the Editorial Board is composed of one physiologist, five nutritionists or nutritional biochemists, and six biochemists. Thus, the growth of the science of nutrition is characterized by the replacement of physiologists by nutritionists or nutritional biochemists, and the term biochemist has largely replaced the term physiological or agricultural chemist.

THE BASIS OF NUTRITION

The manner in which physiology (as a medical science) and chemistry (as a science applied to agriculture) initially contributed to nutrition knowledge can be best illustrated by recalling briefly some of the early research workers who established modern nutrition. Justus von Liebig was a chemist, but since the science of chemistry in his time was young, he served as an apprentice to an apothecary. This did not satisfy him, so he returned to university life in Paris for further study. In 1824 he became professor of chemistry at Giessen and set up the first teaching

laboratory in chemistry in Germany. It is interesting to note that none of Liebig's immediate pupils were physiologists, yet many of his contributions were in physiology. His best known work deals with the "law of minimum". He reasoned that the mineral present in soils in least amount would limit the plants' growth and determine the harvest yield. In general, this law has been the basis not only for minerals but for all essential nutrients in both plants and animals and has served as the basis for the discovery of individual amino acids and vitamins. Upon this principle is based one of our greatest modern industries, artificial fertilizers.

The physiologists honored Liebig because he was an analyst who devoted his life to the systematic analysis of the organs and tissues of plants and animals. He thus had a great influence in furthering exact methods of investigation in medicine and physiology, yet it is said that he never conducted an animal experiment.

Carl Voit is often considered the originator of metabolic research. He was a student of medicine in 1854 where Liebig was professor of chemistry. After completing the medical course, Voit continued his studies under Jolly, a zoologist, Liebold, an anatomist, and Liebig, the chemist. He became professor of physiology at Munich in 1863. Unlike Liebig, who elaborated chemical methods for the analysis of animal tissues and excretions, Voit applied these methods to metabolism studies of the income and outgo of food ingredients in animals and men.

Max Rubner and Graham Lusk were both pupils of Voit; Rubner later became a professor of physiology at Berlin, and Lusk became a professor of physiology at Cornell University Medical School in the United States. Rubner is credited with the discovery that the heat value of the metabolism of the resting individual is proportional to the area of the surface of the body. Lusk accumulated the vast pool of data on human energy metabolism at the Russell Sage Institute of Pathology, Bellevue Hospital, New York, where a clinical calorimeter had been constructed for such studies. This task in itself called for the close cooperation of physicists as well as chemists.

The association between T. B. Osborne and L. B. Mendel is perhaps the outstanding example of teamwork effort toward the advancement of newer nutrition knowledge in this country. Osborne (1859-1929) was a chemist at the Connecticut Agricultural Experiment Station, Storrs, and Mendel (1872-1935) was a physiologist at the Yale University Medical School. Much of our present knowledge of the nutritional value of proteins is based upon the investigations of this congenial research team.

The need for collaborative effort in nutrition research was therefore fully recognized by the founders of modern nutrition science.

PRESENT DAY NUTRITION RESEARCH

In our modern scientific environment, the extensive departmentalization of young disciplines nurtured by physiology has much extended the degree of collaborative effort that is called for in nutrition investigations. A modern nutrition laboratory, for example, relies upon a microbiologist

for the perfection of growth-measurement procedures with micro-organisms for vitamin and amino acid assays of foodstuffs. The chemical microscopists and the experimental pathologists are collaborators in the establishment of detectable derangements in plants or animals that are attributable to nutritional disorders. The endocrinologists and geneticists are valuable adjuncts to the establishment of reliable animal populations for precise nutrition investigations. The cellular physiologists and enzymologists are concerned with the more fundamental questions of metabolic derangements which occur at the cellular level. Appropriate experimental design and intelligent interpretation of research results require the aid of the biometrist. Too often present day nutritionists have been so busy with how to grow animals or plants for maximum production benefit to agriculture that they have not had the opportunity for teamwork effort. The opportunity for teamwork effort with allied sciences as a more fundamental approach to nutrition studies has often had to be abandoned and the nutritionist has had to consent to the gathering of growth data in simple feeding trials. This approach has resulted in many valuable observations even though it has represented a practical approach to production problems in agriculture. Actually, it has resulted in a situation where the nutritionists' observations have often supplied the necessary catalysts for more fundamental studies concerned with isolation of nutritionally essential factors or their role in metabolism.

Vitamin B_{12} was isolated in this country and almost simultaneously in England in 1948. The isolation procedure was greatly facilitated in this country by an observation of a microbiologist working in the Poultry Husbandry Laboratory at Rutgers University, New Brunswick, New Jersey. This worker observed that anti-pernicious-anemia liver preparations contained a growth factor that was essential for the micro-organism *Lactobacillus lactis Doreri* (LLD), and that the activities of liver fractions for the organism were almost identical with their effectiveness as anti-pernicious-anemia agents.

Parallel observations by animal nutritionists served equally effectively as catalysts in the isolation of vitamin B_{12} , since they had clearly established that poultry production (maximum growth) called for supplementation of all-vegetable rations with small amounts of animal products, particularly liver. The further observation by nutritionists that vitamin B_{12} greatly reduced the choline requirement in animals stimulated the extensive studies that have implicated this vitamin as functional in the synthesis and transfer of labile methyl groups.

The great speed with which the cataloging of essential growth factors proceeded during the period 1930 to 1948 seems to have slackened. There are now about 50 nutrients that have been found to play a role in nutrition. How many more there will be is not known. Several additional growth factors for poultry have been postulated but it is generally felt that the list will not expand greatly in the future. This means that there will be and should be a greater effort extended toward the elucidation of function of nutrients in animal metabolism. It is in this area that a

teamwork effort with the various allied scientific disciplines should prove very productive.

Scientific knowledge, nutrition included, has always gone and will always be unappreciated unless it is applied to day by day practices. Recently in animal nutrition, scientific knowledge has been applied very rapidly toward improvement of production. As an example, within a matter of three or four years after the observation that vitamin B₁₂ concentrates in the form of fermentation products contained an antibiotic that served as a growth stimulant for animals, the manufacturers of animal feeds in the United States were using about 15 million dollars worth of antibiotics as supplements in commercial animal feeds. The 10 to 20 per cent increase in growth rate of poultry and swine that is often observed as a result of feed supplementation with antibiotics represents a real economy in animal production. Often the increased growth is reported to represent more efficient production, i.e., more pounds of animal product per pound of feed eaten by the animal.

The use of antibiotics has become an accepted animal feeding practice when there is actually very little basic information available as to the exact mode of action of the antibiotics as growth stimulants. Present indications are that the antibiotics exert their growth-stimulatory effects by changing the micro-organisms that are naturally present in the gastrointestinal tract of animals. It is immediately apparent that the teamwork efforts of nutritionists, biochemists, and microbiologists will be required for the effective pursuit of basic information regarding the role of intestinal micro-organisms in animal nutrition.

The question that may be asked is whether or not it is sound agricultural practice to increase animal production (growth rate) by including a drug in the feed when we still have much to learn regarding the mode of action of the drug as a growth stimulant. Are we on a sound basis when we substitute a drug for sanitation as a sound animal husbandry practice? It appears we are doing just that when recent evidence indicates that antibiotics stimulate growth only when the poultry houses have not been thoroughly cleaned.

WHAT DO WE NEED TO KNOW?

The soundness of our animal production practices rests upon fundamental knowledge of the mode of action of chemical compounds that influence animal growth or animal products obtained. The science of nutrition has reached the stage in its development where pressure of the establishment of identity of nutritionally important chemical compounds can give way to broader questions of the functional aspects of nutrients. This does not mean that the nutritionist has established all that can be learned in growth or production type experiments. Much of our knowledge regarding nutrient requirements is based on results with laboratory animals. Of the twenty-odd vitamins that are known to be necessary for animals we have information with respect to requirements in humans for only a few.

We should catalogue all the factors involved in the nutrition of animals, learn how to assay for these factors in our foodstuff, and then, in addition, determine the need of the factors quantitatively. That is a big problem, but it is the ultimate goal of any program for the development of fundamental knowledge in nutrition. Professor E. B. Hart, Chairman of the Department of Biochemistry at the University of Wisconsin, in 1939 suggested the foregoing in response to an inquiry, "What do we need to know?" This statement still applies since there are yet many gaps in our knowledge of nutrient requirements for man and economically-important animals.

If we should attempt to list broad nutrition problems that deserve research effort, we should mention the following:

- (1) Influence of genetics on nutritional requirements of animals;
- (2) Interrelationships of endocrine function and nutritional status of animals;
- (3) Influence of nutrient intake by the host on the host-parasite relationship that are common to ruminant and non-ruminant physiology;
- (4) Relation of nutrition to disease, particularly the long term or chronic effects of nutritional inadequacy or excess;
- (5) Establishment of optimum nutrient intake information throughout the life span of animals and man;
- (6) Maximum effective utilization of pasture and roughage type feeds as a means of increasing the efficiency of production of meat and milk;
- (7) Importance of soil fertilization or soil treatment practices on the nutritional health of animals and man;
- (8) Impact of nutrition on abnormal growth situations, such as neoplasia.

Many nutritionists could add to this list. Whatever the magnitude or number of the unsolved problems may be, it is obvious that, basically, the important ones call for the teamwork effort of all of the scientific disciplines that have as their objective the solution to the problem of *how plants or animals grow*. With this answer, we can do a better job of growing them.

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Observations on the Summer Behavior and Mortality of Box Turtles in Eastern Virginia

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Early reports on the habits and habitat of the common box turtle, *Terrapene carolina carolina* (Linné), contain a few good guesses and a number of confusing or erroneous views. While it is true that in some seasons this chelonian is "partial to dry woods" (Richardson, et al, 1877), the statement that it has a "particular dislike for water, and soon dies if placed in it" (Kingsley, 1885) is in error. As early as 1842 Dekay noted that in New York box turtles are encountered in swamps and moist places, but he erred in reporting "it never takes to water from choice, and indeed would be drowned if retained there". As many observers subsequently noted, the presence of box turtles in wet places in summer is the rule rather than the exception, yet in 1933 Ditmars reported the behavior of box turtles placed in water as "hysterical in gaining the shore".

Pope (1939) reported "although frequently found in dry woods, it craves a certain degree of moisture when the temperature is high. This is shown by the way great numbers seek large mud-holes, bogs, swamps, shallow ponds, and even the edges of deeper (fresh or salt) water during hot dry spells of midsummer". Evidence that even during the hot spells many box turtles do not seek water sites for aestivation is presented by Conant (1938a). He observed that during and after heavy rains "literally dozens of box turtles were seen on the roads" on summer field trips in southern Ohio, and experiments conducted on turtles "in captivity on hot days showed that specimens almost always left their burrows when their enclosure was sprinkled with a hose". The authors have observed in eastern Virginia that during summer months a woodland area may contain no observable box turtles during dry spells of hot weather, and may be shown to have a considerable population by checking the same region following a period of rain. Field observations have established that these turtles have emerged from terrestrial burrows, and in no case to date has it been clearly established that a box turtle has roamed from an aquatic "aestivation" site following a summer rain though it is likely this occasionally happens. Ewing (1933) points out that mating may occur at any time during the season of activity, but "is most frequently observed" either early in the season, or late in the season "particularly just after a rain". It has not been determined whether the emergence of terrestrial,

burrowing box turtles following periods of rain during the summer months is closely correlated with a breeding inclination, but the authors have not observed pairs in coitus in the field during the hot months.

McCauley (1945) writes that "during dry seasons — great numbers of specimens can be found buried in mud along streams and ponds with only the tops of their shell exposed". This observation has been frequently confirmed by the authors in Tidewater Virginia, where it is usual to find two or three specimens in the mud and water-filled road ruts near abandoned logging camps scattered over the lower York-James peninsula. McCauley (*ibid.*) adds, "by no stretch of the imagination can this species be considered at home in deep water. The ungainly shell and the legs adapted for a terrestrial existence render swimming, in the sense that it is performed by other turtles, impossible". As the box turtles enter shallow water during hot periods, however, they frequently either take in enough air to become buoyant or bury themselves under the water and mud at the edge of the aquatic area. Brimley (1943) reports a case of what appears to be true aestivation under water, in which he dug up a specimen that was buried deep in the mud of a partly dried up pool, in a habitat in which one might naturally expect a snapping turtle. The senior author encountered similar cases during July of 1950 and 1952 in the Williamsburg area of James City County, Virginia. On one occasion three adult-sized box turtles were found buried beneath the mud in a shallow road-rut pool two miles south-west of Williamsburg. In the case of each specimen the carapace was entirely beneath the mud, and the site of burial was beneath from one to three inches of water. On being exposed to sunlight and air following excavation, one specimen showed prompt activity and the other two remained inactive, with shells closed, for about 30 minutes. As Penn and Potthast (1940) point out, "hibernation and aestivation in so far as the terms apply to box turtles can be loosely defined as states of torporous activity at low and high temperatures respectively". Neither Brimley (*ibid.*) nor the senior author evaluated the extent of torpor present in their buried and submerged specimens, thus proof that aestivation was involved is lacking, but if it was present, it was promptly terminated in some specimens by resumed activity following excavation and disturbance. In extensive observations on the mid-summer activity of 75 captive specimens, Allard (1935) reports no "definite — period of inactivity" (either diurnal or nocturnal), stating that during hot periods specimens slept by day or night in tunnels in a large debris pile in their enclosure, and that "at no time, from spring to October, have the turtles shown any decided inclination to refuse food, although the hunger impulse naturally seems strongest in early summer. In observing the activity of 24 captive specimens during July, 1953 (a month in which 19 days have had temperatures above 90° F. in the Williamsburg area) there has been no period when the response to food or handling did not result in prompt activity by the turtle. Penn and Potthast (1940) describe a difference between winter and summer dormancy in *Terrapene major Aggasiz* in the New Orleans area. They report that while the for-

mer was erratic, the latter was "sure to be at least diurnally periodic, subject of course, to interruption by a cooling rain or an abrupt drop in temperature". The authors feel this oversimplification of the concept of aestivation in box turtles needs substantiation since the periodic activity is also related to photic orientation, and in addition evidence of reduced metabolic activity during a period of non-diurnal midsummer inactivity has not been established for a number of specimens exposed to the same environmental stresses. Conant (1938b) provides a six year summary of reptiles collected in Lucas County, Ohio which shows that in the northern part of its range the hibernation of *Terrapene c. carolina* is not erratic, being continuous from November through April. Neill (1948) shows that the hibernation is erratic in the southern part of the range.

Carr (1952) summarizes midsummer activity in reporting "box turtles often burrow into moist soil or leaf mold during the hottest parts of the day or even seek water, where they may merely sit in shallow places and pass the hot spells or may swim in a desultory fashion or crawl about on the bottom; some may even bury themselves in the bottom mud during droughts". The authors have observed that, in the Virginia area studied, the burrowing activity and the migration to "seek water" do not coincide with the hottest parts of the day; they precede it. During the periods of highest temperature, activity of box turtles is minimal, providing the turtle has found a place of retreat from the heat.

If retreat from areas exposed to maximum heat is not managed by box turtles before the hottest parts of midsummer days occur, mortality due to excessive heat results. During June, 1953 new ditches were excavated on either side of Quarter-Pass Road (Rt. 619) one mile south of Williamsburg. The ditches were steep-sided, and during morning hours were exposed to full sunlight. On June 19 the senior author noted four heat-killed box turtles which had tried to cross the ditch, but had failed to escape due to the steep sides. On July 2, six additional victims were noted in the same area. The junior author reports an instance of a similar nature, in which two snapping turtles, *Chelydra s. serpentina* (Linne), one painted turtle, *Chrysemys p. picta* (Schneider), and three box turtles apparently died due to excessive heat on June 27, 1953. The specimens were penned in an enclosure lacking water by two reptile enthusiasts in Hampton, Virginia. They remained in this enclosure from 7:00 A.M. to 1:00 P.M. in a sparsely shaded area, and by the latter hour the six specimens mentioned were dead, and one other was still living.

Neill (1948) reports that in Richmond County, Georgia, the erratic hibernation behavior of the box turtles expose them to the hazards of sudden cold spells, and that "vast numbers of the reptiles freeze to death, and the woods are littered with their shells". The authors have also noted the remains and shells of many box turtles in the woods, but have encountered no evidence of death due to specimens being caught out of hibernation in Tidewater Virginia. They suggest that destruction of hibernating box turtles by predatory mammals can account for the winter deaths, and that one of the factors in midsummer death is excessive heat during drought.

periods, in areas where the turtles find inadequate debris to retreat under, and ground too hard and dry for burrowing.

SUMMARY

1. Box turtles adopt aquatic and burrowing habitats during hot mid-summer months; they are found both on land, and in water, either remaining at the surface, or buried under mud.
2. Specimens in terrestrial burrows emerge at any time of day during or following periods of rain.
3. Aestivation is uncommon in box turtles in eastern Virginia, since active feeding, wandering from burrows and ability to respond promptly to stimuli are retained during midsummer.
4. Activity is greatest during the coolest parts of the day — usually early morning hours in hot weather.
5. Mortalities have been noted among turtles unable to escape from direct sunlight and high temperatures during the late morning hours of hot days.

ACKNOWLEDGMENTS

The authors are indebted to D. A. Perry and J. C. Stump of Hampton, Virginia for information of the summer mortality of turtles under their observation.

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An Equation For Sigmoid Curves

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Data that lead to sigmoid curves are common in many branches of pure and applied science. Equations for such curves are usually desirable, particularly equations that represent close fits and permit easy differentiation so as to provide accurate slopes. In some instances the Gompertz and modified Gompertz equations (Davis, 1943: 57).

$$y = a b^{\frac{x}{c}} \quad \text{and} \quad y = \alpha + a b^{\frac{x}{c}}$$

meet these requirements; in others, these expressions do not fit the data well and, hence, are inadequate as a basis for analytical determination of slopes.

Many sigmoid curves, both normal and skewed, can be fitted satisfactorily by the equation

$$O\int = \frac{x - x_1}{a + bx} \quad (1)$$

where $O\int = \log \left(\frac{20 y}{\log (100 - y)} \right)$, x_1 corresponds to $y = 0.1$, and

a and b are the intercept and slope, respectively, of the straight line that results when $\frac{x - x_1}{O\int}$ is plotted against x .

On differentiation, Equation 1 yields

$$\frac{dy}{dx} = \frac{a + bx_1}{(a + bx)^2 S} \quad (2)$$

where $S = 0.4343 \left(\frac{1}{y} + \frac{0.4343}{(100 - y) \log (100 - y)} \right)$

Table I of Document No. 4188¹ lists values of $O\int$ and S for values of y in steps of 0.1 unit from 0.1 to 20.0 and from 95.0 to 98.9, and in steps of 0.5 unit between $y = 20$ and $y = 95$. Linear interpolation suffices throughout the table.

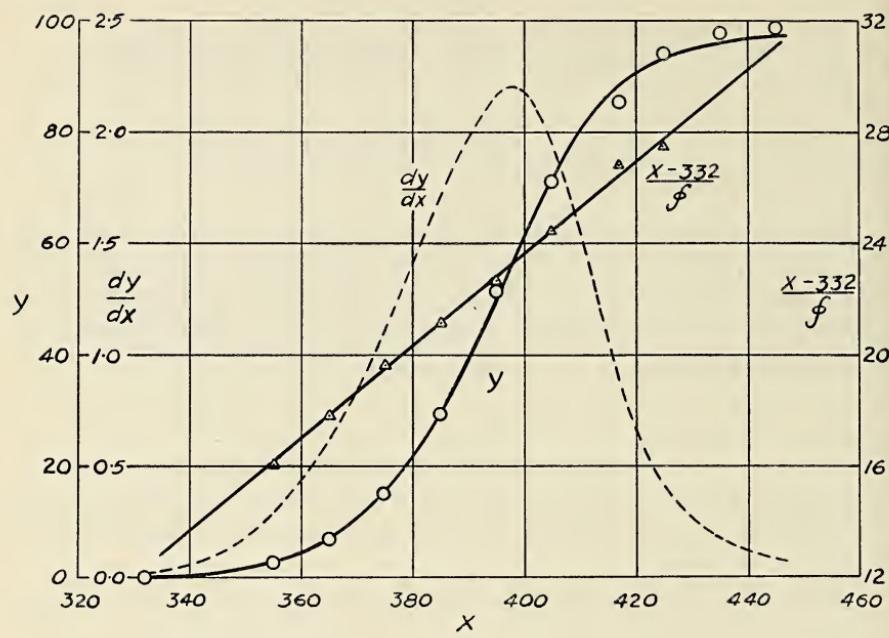


Fig. 1

Table II
Data of Gilliland and Baddour

y	x	x-332	Of	$\frac{x-332}{Of}$	Of	y, calcd.	Dev.	S	$\frac{dy}{dx}$
0.0	332	0	-∞	0.00	0.000	0.1	0.1	4.343	0.019
2.7	355	23	1.434	16.04	1.422	2.6	-0.1	0.1662	0.285
7.0	365	33	1.852	17.82	1.851	7.0	0.0	0.06328	0.616
15.0	375	43	2.192	19.62	2.207	15.5	0.5	0.02913	1.121
29.4	385	53	2.502	21.18	2.508	29.8	0.4	0.01605	1.728
51.3	395	63	2.784	22.63	2.766	49.7	-1.6	0.01094	2.182
71.0	405	73	2.987	24.44	2.988	71.1	0.1	0.01058	1.960
85.5	417	85	3.168	26.83	3.218	88.3	2.9	0.02002	0.886
94.0	425	93	3.383	27.49	3.355	93.3	-0.7	0.03894	0.414
97.8	435	103	3.757	—	3.506	96.0	-1.8	0.08366	0.172
98.8	445	113	4.397	—	3.642	97.2	-1.6	0.1575	0.082

¹ Material supplementary to this article has been deposited as Document number 4188 with the ADI Auxiliary Publications Project, Photoduplication Service, Library of Congress, Washington 25, D. C. A copy may be secured by citing the Document number and by remitting \$1.25 for photoprints, or \$1.25 for 35 mm. microfilm. Advance payment is required. Make checks or money orders payable to: Chief, Photoduplication Service, Library of Congress.

The following example, which serves to illustrate the use of Equation 1 and of Table I of Document No. 4188¹, employs the data of Gilliland and Baddour (1953) where x is the volume of solution through an ion exchange bed and y is a ratio of concentrations, as presented in Figure 5a of their paper.

Plot the $x - y$ data of Table II to attain the solid sigmoid curve of Figure 1, note that x_1 (the value of x that corresponds to $y = 0.1$, substantially the same as that for which $y = 0$) is 332, and fill in the column in Table II that is headed " $x - 332$." Use Table I and enter in the O_f -column the value of O_f that corresponds to each value of y , compute values of $(x - 332)/O_f$ and enter them in the column so headed. Plot $(x - 332)/O_f$ against x in Figure 1 and note that the points, enclosed in triangles, lie along a straight line. Divide the data into two equal parts (Davis, 1943:4), write the summation equations

$$74.66 = 4 a + 1480 b$$

$$\text{and } 101.39 = 4 a + 1642 b$$

to correspond to the general equation $\frac{x - x_1}{O_f} = a + bx$, and solve them

simultaneously to yield $a = -42.395$ and $b = 0.16500$. From these values of a and b , find the calculated values of O_f , enter them in the column headed " O_f , calcd." and interpolate values of "y, calcd." and S from Table I. Plot the calculated values of y against x in Figure 1 and note how closely the curve represents the original plotted data. Use

Equation 2 and the values of S to compute $\frac{dy}{dx}$, the slope of the sigmoid

curve. Plot these slopes as the dotted curve in Figure 1.

This method for determining the equations of sigmoid curves has also been applied successfully to normal and skewed data in the fields of size separation, distillation, and atomic heat capacity.

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A Rapid Slide Screening and Diagnostic Test for Newcastle Disease

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Virginia Department of Agriculture*

Much has been learned about viral hemagglutination since the report of Hirst (1941) that influenza viruses agglutinate chicken red blood cells. Hirst (1942) reported that erythrocytes which had been agglutinated by influenza virus, strains PR8 and Lee, subsequently could be dissociated from the virus. After dissociation, the erythrocytes were no longer capable of adsorbing a detectable amount of fresh virus of either strain or a mixture of the strains or of agglutinating in their presence. He suggested that this hemagglutination phenomenon of the erythrocytes might be an *in vitro* counterpart to natural infection.

Hirst (1942 & 1949) suggests that the agglutination phenomenon is due to receptors on the red cell. He states that the virus attaches itself to the red cell receptor, and after four to six hours it is eluted from the cell, removing the receptors by enzymatic action. Since, there are no receptors left on the cell for the virus there is no agglutination when fresh virus is added to the resuspended cells.

These suggestions and statements were the basis for this study. This investigation was concerned with an *in vivo* alteration of the agglutinability of the erythrocytes when they come in contact with Newcastle disease virus. Forty-six young chickens of various breeds were inoculated with Newcastle disease virus and agglutination tests were run, observing the changes in sensitivity or agglutinability of the erythrocytes as the disease progressed.

The ultimate aim of such a study was to apply this change of agglutinability of the chicken red blood cell to a rapid diagnostic test for the presence of Newcastle disease virus.

MATERIALS AND METHODS

Virus.—The virus used in this investigation as the agglutinating agent was a very mild strain of Newcastle disease obtained from Dr. F. R. Beaudette of the New Jersey Experiment Station, which had had its 75th egg passage. This virus strain is now known as the B1 or Blacksburg strain (Hitchner and Johnson 1948).

Preparation of the virus strain.—The virus strain was prepared by inoculating 0.1 ml. of infected allantoic fluid into the allantoic sacs of 11 day old chick embryos. After 48 hours incubation at 37° C. the eggs were placed at 4° C. overnight, and blood free allantoic fluid was removed the following day. If necessary the cellular debris was removed by a

short centrifugation, and the virus stored at 4° C. in the fluid state. The virus was formalized with 0.1% formalin a week before use.

Red Cells.—Red cells were obtained by venal puncture of the wings of the experimental chickens.

Agglutination.—A loop of whole blood, approximately 0.004 ml. in amount was mixed with 0.05 ml. of the prepared B1 virus on a glass plate, over a light source. This plate was divided into squares of 2.5 cm. The loop used to remove the whole blood was made of nichrome wire gauge 26 (Brown and Sharp) with a diameter of 0.4 cm. The drop of blood and the virus strain was mixed with the loop 25 times. The plate was then gently rotated and after a few seconds the test was read.

Reading the test.—An agglutination, even that just discernible with the naked eye indicates the absence of the virus of Newcastle disease. No agglutination whatever is an indication of the presence of Newcastle disease.

RESULTS AND DISCUSSION

It has been found that blood serum from non-infected chickens (those whose whole blood was agglutinated in the rapid slide test) will give a negative test when submitted to the standard hemagglutination-inhibition (HI) test, and in most cases a positive HI when the serum was obtained from blood that failed to agglutinate in the rapid slide test. One hundred and eighty cases were positive with the HI while one hundred and eighty-nine showed absence of agglutination with the rapid slide. Comparative results obtained are shown in Table I. This discrepancy is attributed to the assumption that the rapid slide whole blood test picks up Newcastle disease reactors quicker than the HI. During more than four years of very close observation this assumption has proven true, as shown in the following paragraph.

For more than four years the rapid slide whole blood test has been used in the Regional Diagnostic Laboratory at Accomac, Virginia, as a screening and diagnostic test in detecting Newcastle disease in broiler flocks. One thousand one hundred and forty-four birds from four hundred and seventy flocks have given a positive test for Newcastle disease with the rapid slide whole blood method. More than two thousand birds from at least one thousand individual flocks have given a negative test with the rapid slide whole blood test. All of these flocks were checked from time to time, and in each case where the disease was diagnosed by the rapid slide method, symptoms or syndromes of Newcastle disease developed within a week, or less.

TABLE I.—Comparative Results Obtained from 38 Lots of Chickens with HI and Rapid Slide Methods

Lot No.	HI		Rapid Slide	
	Birds Positive	Birds Negative	Absence of Agglutination	Agglutination
1.	6	0	6	0
2.	6	0	6	0
3.	0	6	0	6
4.	0	3	0	3
5.	6	0	6	0
6.	0	4	0	4
7.	5	1	6	0
8.	6	0	6	0
9.	6	0	6	0
10.	6	0	6	0
11.	6	0	6	0
12.	5	1	6	0
13.	5	1	6	0
14.	6	0	6	0
15.	6	0	6	0
16.	6	0	6	0
17.	6	0	6	0
18.	0	3	0	3
19.	0	6	0	6
20.	0	6	0	6
21.	6	0	6	0
22.	3	3	6	0
23.	6	0	6	0
24.	6	0	6	0
25.	6	0	6	0
26.	6	0	6	0
27.	6	0	6	0
28.	6	0	6	0
29.	6	0	6	0
30.	4	2	6	0
31.	6	0	6	0
32.	6	0	6	0
33.	6	0	6	0
34.	6	0	6	0
35.	6	0	6	0
36.	6	0	6	0
37.	4	1	5	0
38.	4	0	4	0
Totals	180	37	189	28

SUMMARY

A rapid slide whole blood test for the screening of Newcastle disease reactors in chickens has been described.

Employing this method, a Newcastle disease reactor could be diagnosed in about two minutes.

The method has been used successfully for more than four years in diagnosing one thousand one hundred and forty-four cases of Newcastle disease in four hundred and seventy flocks.

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The Origin of Branching in the Aerial Shoot of *Psilotum nudum*¹

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There are conflicting reports in the literature regarding to rather pertinent aspects of the developmental morphology of *Psilotum*. The first of these is concerned with the presence or absence of appendages in the axils of the ramifications. Prantl (1876) reported that an appendage is present below each point of bifurcation in *Psilotum*. From this he concluded that branching could not be dichotomous, but that one of the two branches was in the axil of an appendage. Solms-Laubach (1884) reported that appendage position was not regular in regard to branching. Ford (1904) and Stiles (1910) both report that in *P. flaccidum* an appendage is always associated with a dichotomy and that occasionally the appendage may be "carried up" by differential growth.

The second aspect on which conflicting reports have been published is concerned with the role of the apical cell in dichotomy. Solms-Laubach (1884), speaking of both *Psilotum* and *Tmesipteris*, asserts that in dichotomy the single apical cell may either divide medianly into two, or it may disappear altogether before bifurcation. Pritzel (1902) states that bifurcations take place as the result of the splitting of the whole apex into two, whereby the old apical cell disappears. Ford (1904) reported that the apical cell is not always present in recently forked branches, but may develop later.

External aspects.—When a rhizome apex of *Psilotum nudum* (L.) Beauv. is exposed to light it turns upward and becomes green. Small scale-like appendages are produced from the apex in a leaf-like fashion (fig. 17). These are very small, sparse and irregular in distribution on the apex. They appear to arise at a considerable distance from the summit of the apex. A lateral expansion of the region immediately below the apex appears, giving a club-shaped appearance to the young shoot. A period of rapid production of scale-like appendages associated with some growth in length of the axis soon follows. The apex is eventually hidden by overlapping appendages (fig. 16). Up to this stage of development the appendages have become progressively larger, closer to each other, and closer to the summit of the shoot apex. The young aerial shoot may be ca. 2 cm in length at this stage. No external manifestation of branching is evident, but if the appendages are removed and the apex is examined from above with moderate magnification one or more dichotomies may be observed (fig. 14).

¹ This represents a portion of a Ph.D. thesis submitted to the Botany Department, University of Minnesota. The writer wishes to thank Dr. E. C. Abbe and Dr. H. P. Banks for their suggestions and criticisms.

The shape of the apex following the stage shown in fig. 17 departs from the circular cross-section to become elliptical. The two ends of the flattened apex later become slightly raised above a central fissure. Situated at the outer edge of the central fissure is an appendage primordium. The two resulting new apices, also elliptical in cross-section, both divide as did the mother apex and again an appendage primordium is located at the outer edge of each of the two new fissures. This manner of branching may continue until the first four sets of dichotomies are initiated (i.e., until as many as 16 new apices are formed). At this stage the entire apex of the young aerial shoot may still appear similar externally to the one shown in fig. 16, or it may show some evidence of lateral expansion beneath the cover of the appendages. The vertical distance from the base of the first formed fissure to the most distal portion of the last-formed apex may be as little as 0.5 mm.

The appendage-dichotomy relationships are also illustrated in fig. 15 which is an outline drawing of a longitudinal section of a young aerial shoot. Appendage 1 is inserted at the outer edge of the axil of the first bifurcation which is in the plane of the diagram. Appendages 2a and 2b are inserted each at the outer edges of the axil of one of the second order bifurcations which are perpendicular to the plane of the diagram. Appendages 3a and 3b are each inserted at the outer edge of the axil of one of the four third-order bifurcations.

In figs. 1-12, the appendage-dichotomy relationships are also shown. The total vertical distance between fig. 1 and 12 is 2.5 mm. A total of four orders of branching is represented as indicated by the numbered appendages.

The following stages are characterized by a pronounced growth in the length of the inter-dichotomy regions resulting in the separation of the appendages from the dichotomies with which they were associated by as much as 4 cm. Slight differentials may be introduced during the period of most rapid growth in length so that an appendage which was originally in the axil between two branch primordia (apices) may be shifted in position to a point slightly to one side of the axil or even slightly above it.

The present study has shown that in *Psilotum nudum* an appendage is present in the axil of each of the bifurcations which are initiated in the aerial shoot shortly after it has emerged from below the substratum.

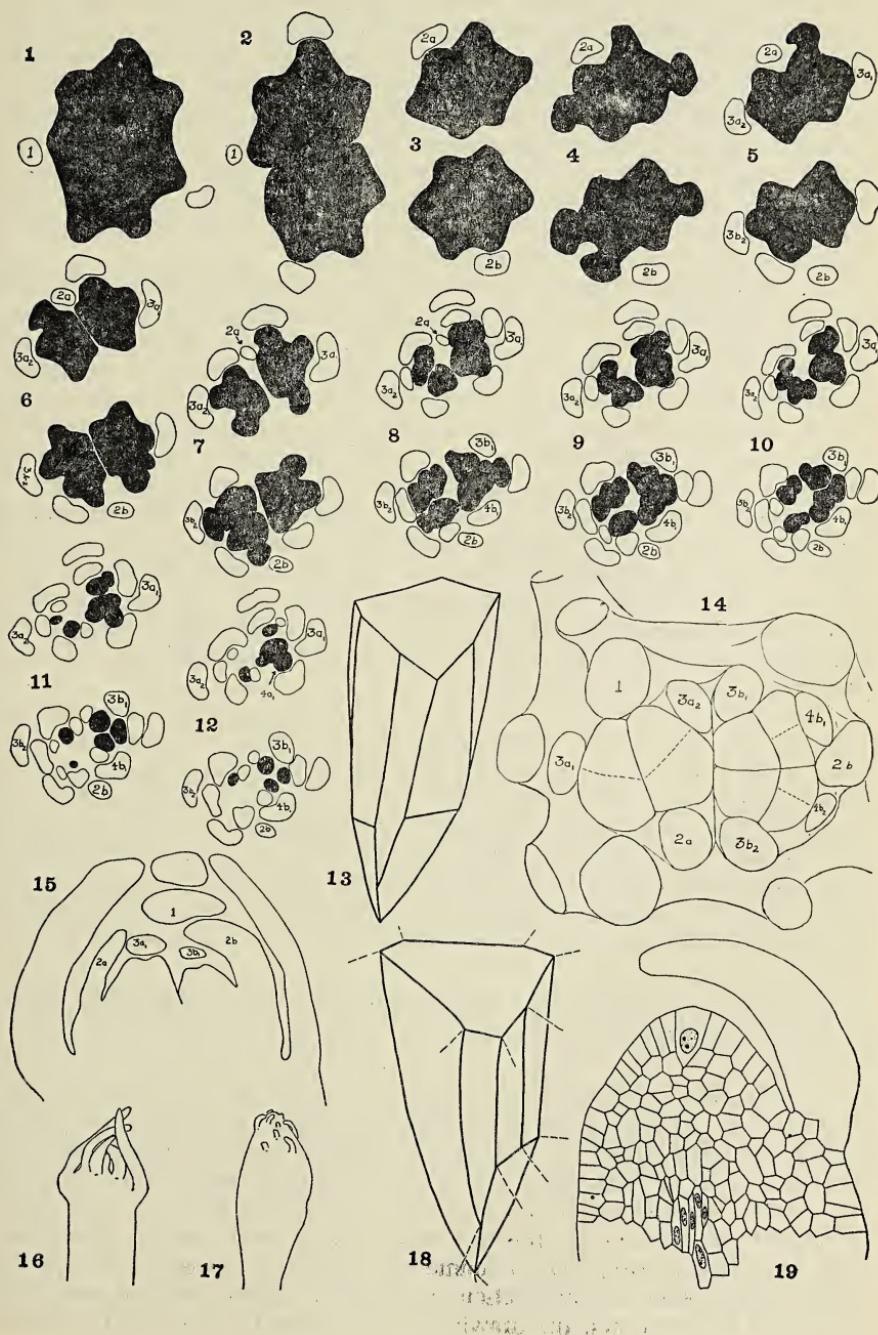
Hofmeister (1851) proposed that the growing apex is usually stable when it is circular in outline and that the apex will tend to re-assume a circular outline following an event which disturbs this condition. This hypothesis, which was also adopted by Schoute (1936), seems to be diagrammatically applicable in the case of *P. nudum*. The event which tends to disturb the circular outline of the shoot apex is the production of an appendage primordium. The tendency of the shoot apex to re-assume a circular outline is manifest by the production of two new growth centers in the apex, i.e. a bifurcation. Trifurcations are produced when three appendage primordia are produced in such a fashion as to result in a trilobed apex.

The first three or four orders of branching appear to be produced in rapid succession. The original apex seems to "explode" in their production. This establishes a lower system of nearly symmetrical dichotomies.

In the lower symmetrical system, the branching pattern is often regularly decussate. Bifurcations of the same order are generally situated at the same level. Where trifurcations are represented in the second or third order ramifications, they are usually duplicated or quadruplicated, thus preserving the symmetry of the system. Several shoots were observed which exhibited trichotomies at the two corresponding points of second order ramification, one which exhibited trichotomies at the four points of third order ramification and one which showed this type of branching at the point of first order and at the three corresponding points of second order ramification. Trichotomies are rare and occur at only about 5% of all points of branching.

Distal to the first set of dichotomies (the first 3 or 4) there is a region which exhibits less regularity. Here there may be two to four systems of dichotomies, but not corresponding in position on the various branches of the system, i.e., the inter-dichotomy stem units of similar orders vary in length. Their origin is considerably later in time than the first set. Definite appendages in this region cannot be associated with particular dichotomies. Fertile appendages are present only in the distal irregular system. The individual branches in the distal system almost regularly have three ridges, and relatively abundant appendages arranged in a 1/3 phyllotaxy.

Explanation of figures.—*Figs. 1-12.*—Camera lucida diagrams of cross-sections through the tip of a branching shoot of *Psilotum nudum*. The sections are in serial order and cover a longitudinal distance of 2.5 mm. from the most distal (*fig. 12*) to the most proximal (*fig. 1*). *Figs. 13 and 18.*—Three dimensional views of two apical cells from the aerial shoot of *P. nudum*. *Fig. 14.*—Diagram of the top view of the apex shown in *fig. 16* with some of the appendages removed (see text). *Fig. 15.*—Diagram of a median, longitudinal section of the apex of a young aerial shoot of *P. nudum* about 2 cm. above the ground level. *Fig. 16.*—Diagram of the apex of a young aerial shoot of *P. nudum* about 2 cm. above the ground level. *Fig. 17.*—Diagram of the apex of a young aerial shoot of *P. nudum* at or just above the ground level. *Fig. 19.*—Camera lucida drawing of a median longitudinal section of a shoot apex of an aerial shoot of *P. nudum* after the establishment of the proximal orders of ramification. The apical cell and the procambial cells are shown with nuclei. The labeling system used for the appendages in *figs. 1-12, 14, and 15* is as follows: appendage 1 is inserted at the outer edge of the axil of the first order ramification; appendages 2a and 2b are inserted each at the outer edge of one of the axils of the two second order ramifications; 3a₁, 3a₂, 3b₁ and 3b similarly of the four third order ramifications, etc. Unlabeled appendages are those which are not primarily associated with branching.



The shoot apex of Psilotum nudum.—The apex of a very young aerial shoot has essentially the same structure as that of a rhizome. When it becomes green the structure and activity, however, change considerably. The surface cells located at the summit of the apex divide more frequently in an anticlinal plane and soon the apical cell, still three sided, departs from its previous broad wedge shape and approaches somewhat the narrower columnar shape of the adjacent superficial cells as viewed in a longitudinal section. Following the establishment of the proximal symmetrical system of dichotomies, the apical cell in each of the ultimate apices is again broad and wedge-shaped (fig. 19).

The anticlinally elongate superficial cells, which are adjacent to and derived from the apical cell, divide to produce isodiametric cells on their inner sides (fig. 19). These cells divide essentially transverse to the stem axis to result in the production of several rows of cells immediately below the apical cell which give rise directly to a solid procambial strand in the center of the axis. Where a relatively small procambial strand is produced, those cells which in other stems give rise almost exclusively to the procambial strand may in addition contribute to a small extent to the formation of the cortex. Where a relatively large procambium is produced, e.g., in aerial shoots before the initiation of the first set of ramifications, the procambium may be derived not only from the inner cells cut off from the first derivatives of the apical cell, but also from inner cells cut off from superficial cells two or three cells removed from the apical cell and to some extent from second inner cells cut off from the first derivatives of the apical cell.

Periclinal divisions in the surface layer are frequent within about ten cells of the apical cell. From this point periclinal divisions are rare. They may, however, occur so late that the differentiated epidermis may occasionally be two cells thick. Ford (1904) reports that each cell which is cut off from the apical cell divides by a tangential wall into an inner and an outer cell, the outer layer thus produced forms the dermatogen. This early establishment of the protoderm, or dermatogen, adjacent to the apical cell has not been confirmed. In view of the late periclinal divisions in the superficial layer, a protoderm cannot be considered as present at all.

The cortex is derived in the same manner as is the procambium, except primarily from superficial cells which are more than one cell removed from the apical cell.

In order to view the exact 3-dimensional shape of the apical cell, two models (fig. 13, 18) were constructed of different apical cells. Each model was constructed as follows. A camera lucida drawing of each section in a serial cross section of an apical cell was made on a stiff card. The apical cell measured 80μ in length and the sections were 8μ thick, so that 10 cross sectional drawings were used in each model. The drawings were made using the oil immersion objective and in each case the upper focal plane of the section was drawn. Each drawing was then cut out of the card and the drawings were arranged in order. The model

was then built around the drawings as forms, so that the original drawings were on the inside of the completed model in their proper positions. Of the two apical cells reconstructed one had a total of 11 sides while the other had 10. Each had three obvious cutting faces.

Immediately after the first set of dichotomies is initiated in *Psilotum nudum* when little or no external manifestation of branching is evident, the eight or sixteen new apices are distributed uniformly over the summit of the old apex which may be expanded very slightly or not at all. If the original apical cell of the undivided mother apex had played a direct role in giving rise to the new apices, the new apices would necessarily have to be clustered on the central portion of the dome of the old apex. It is therefore concluded, not only from evidence offered by the spatial arrangement of the daughter apices, but also by the failure to find any direct histological evidence to support a direct role of the apical cell in dichotomy, despite critical examinations of a number of serial cross sections, that the apical cell does not play a direct role in the ontogeny of the first set of dichotomies. In the development of subsequent dichotomies, each pair of new apices produced is often situated quite close to the summit of the mother apex and frequently each apical cell is situated quite close to the inside of the young primordium, so that the spatial arrangement suggests that the apical cell of the parent apex divided medianly to establish the apical cells of the two daughter apices. It is possible to accept Solms-Laubach's (1884) interpretation as applied only to the ontogeny of those dichotomies of the distal irregular branching system of the aerial shoot and Pritzel's (1902) interpretation as applied to the earlier formed ramifications.

SUMMARY

In the growth of the aerial shoot of *Psilotum nudum*, the lower orders of ramification are initiated in rapid succession, nearly simultaneously. This is accomplished by division and subdivision into twos (or threes) of the apices before any appreciable elongation of the inter-dichotomy (or trichotomy) stem units has taken place. In the axil of each bifurcation there is present an appendage primordium which may later be shifted in position to a point to one side or slightly above the axil. Following Hofmeister (1857) and Schoute (1936), the shoot apex is considered stable when circular in outline. After an event tending to disturb this condition (i.e., the production of an appendage primordium) the shoot apex will readjust by division into two new apices. Three appendage primordia are concerned in the initiation of a trifurcation. The apical cell does not play a direct role in giving rise to new apical cells in connection with the initiation of the lower orders of ramification, but may do so in the initiation of the distal orders.

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News and Notes

(Editor's note: News contributions should be sent to the person whose name appears at the end of the appropriate section.)

MINUTES OF THE COUNCIL MEETING, CHARLOTTESVILLE, NOVEMBER 8, 1953

A meeting of the Council of the Virginia Academy of Science was held in the office of President Gwathmey, Cobb Chemical Laboratory, University of Virginia, Charlottesville, at 10:30 A.M. Present were: Walter S. Flory, Jr., President-Elect I. G. Foster, Horton H. Hobbs, Guy W. Horsley, Ladley Husted, Paul M. Patterson, Marcellus Stow, Stanley B. Williams, Fred Young, and Foley F. Smith. President Allan T. Gwathmey presided. First order of business was reading of the Minutes of the last meeting of the Council in May 1953, Lexington. The Minutes were approved.

President Gwathmey discussed the desirability of a meeting of all Section Chairmen and Secretaries; to discuss arrangements for the Annual Meeting of the Academy, May 6, 7, 8, at the University of Virginia, and it was decided to call a meeting of these officers sometime in January.

I. G. Foster made a brief report of the meeting of the committee appointed by President Gwathmey to study the operation of the Junior Academy of Science.

Marcellus Stow made a brief report for the Committee on Secondary School Science Teachers, and also suggested that the date and place of the Annual Meeting of the Academy be placed on the Secondary School calendar which is sent to all high schools in the State. In this connection Walter Flory commented on the new consolidated school in Clarke County and its inadequate facilities for science teaching.

Guy W. Horsley reported on plans for raising money for the operation of the Junior Academy of Science. It was suggested by this committee that a new class of membership in the Academy be created; to be known as a "Business Membership"; dues for which will be \$100.00 per year. A special letter will be written to invite certain business and industrial firms to join the Academy on this basis. The revenue from such memberships is to be used for the annual operation of the Junior Academy and Science Talent Search, and for such other purposes as the Council may direct.

As this would require a change in the Constitution, motion was made and passed, that such a class of membership be established, and that publication of these minutes in the Virginia Journal of Science would constitute notice of such a proposed change in the Constitution. Article III of the Constitution: "Members" will now have an addition, Section 6, "Business or industrial organizations which pay dues of \$100.00 annually,

shall be Business Members of the Academy. Such dues will be used in the annual operations of the Junior Academy of Science, and the Science Talent Search; and other similar purposes as directed by the Council."

Walter S. Flory reported for the Research Committee that approximately \$1,000.00 would be needed for the present requests for grants-in-aid, and continuation of the Dismal Swamp project.

Marcellus Stow commented on the status of this project and said that he felt the book would be ready for publication next year, and that there would be no need at this time for any further grants-in-aid for this purpose, but any such request should be left to the decision of the Research Committee.

The Secretary-Treasurer reported that two thousand dollars previously carried in the Research Fund checking account had been turned over to the Trust Department of the First and Merchants National Bank, Richmond, for short term investments, so that some income could be derived from this money not needed at present by the Research Committee.

The Secretary also noted the necessity for decision on the billing date of the Academy, due to the change in the fiscal year from May 1 to April 31 to the calendar year. This would mean that members who have paid in advance have paid to January 1, 1954. It was decided that billing would be for the 1954 calendar year, and that May 1953 to January 1, 1954 be termed a year as far as dues are concerned.

Mr. Young, of the University of Virginia Chemistry Research Staff, Chairman of the Local Committee on Arrangements, reported on the plans of this committee for the next annual meeting. It was noted that Russell Rowlett, of the Virginia Carolina Chemical Company, Richmond, has been appointed Chairman of the Publicity Committee for this meeting.

A request from the Department of Geology of V. P. I. for \$650.00 towards the publication of a booklet on "Virginia Minerals and Rocks" was acknowledged. It was decided that such a request could not be granted at this time.

It was decided that at the Annual Meeting the senior program would be suspended from twelve to one on Friday in order that the senior members might attend the main meeting of the Junior Academy to be held at that time. It was also planned to invite the junior members to attend the section meetings of the Senior Academy. Senior members were to be requested to make a special effort to associate with the junior members and to welcome them to the section meetings.

It was suggested that funds from certain research foundations might be available for scholarships for science teachers; and that meetings of the college science teachers in the State would be interested in such possibilities.

The meeting adjourned at 1:15 P.M.

FOLEY F. SMITH, *Secretary*

AGRICULTURAL SCIENCE SECTION

Dr. Seymour L. Kalison has been appointed Professor in the Extension Service at Virginia Polytechnic Institute. He will serve as Extension Specialist of Livestock Diseases and will organize an educational program related to the control of such diseases.

The Department of Biochemistry and Nutrition at Virginia Polytechnic Institute recently received a grant of \$6500 from the National Institutes of Health to study nutritional edema in experimental animals.

The Department of Biochemistry and Nutrition at Virginia Polytechnic Institute, in cooperation with the Department of Biology (Animal Disease Section), perfected a method (Virginia Agricultural Experiment Station Technical Bulletin No. 121, September, 1953) for the detection of highly chlorinated naphthalenes in lubricants, the compounds that produce hyperkeratosis (X-disease) in cattle.

G. Talbot French, Virginia State Entomologist and director of the Division of Plant Industry, State Department of Agriculture, retired January 15 after serving with the Department 42 years. Educated at what is now the University of Massachusetts and at Cornell University, Mr. French has been president of the Association of Official Seed Analysts of North America, the Eastern Plant Board, and the Seed Control Officials of the Northeastern States.

Mr. French is a past chairman of the Section on Plant Pest Control and Quarantine of the American Association of Economic Entomologists, and was a member of the National Plant Board, the American Phytopathological Society; the American Association of Economic Entomologists, the American Association for the Advancement of Science, the Virginia Academy of Science, the Virginia State Horticultural Society and the Virginia Nurseryman's Association.

Succeeding Mr. French as State Entomologist and director of the Division is C. R. Willey, who has been Associate State Entomologist in charge of crop pest control. Mr. Willey received his B.S. degree from Virginia Polytechnic Institute in 1920 and a M.S. from the same institution in 1922. He is a member of the Entomological Society of America and the Eastern Plant Board.

Dr. C. C. Brooks, Ph.D., University of Missouri, will begin his position in Animal Husbandry at Virginia Polytechnic Institute March 1, 1954, doing $\frac{3}{4}$ time teaching and $\frac{1}{4}$ time swine research. He is filling the vacancy created by the resignation of Professor D. B. Allen.

Dr. W. E. Chappell, Plant Physiologist, Department of Plant Pathology and Physiology, Virginia Agricultural Experiment Station, Blacksburg, Virginia, received an award for presenting the outstanding paper in the Agronomic Section of the Northern Weed Control Conference, which was held in New York City in January, 1954. His paper was entitled "Chemical Versus Cultural Control of Weeds in Soybeans."

Denver D. Bragg, Associate Extension Poultry Husbandman, Virginia

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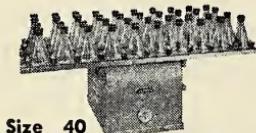
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Polytechnic Institute, accompanied Virginia's 4-H poultry representatives to the Poultry Fact Finding Conference held in Kansas City February 12 to 15. Kermit Spruill, a first year poultry major at Virginia Polytechnic Institute and Gerald Reed Taylor of Accomac County, were selected for this trip because of their outstanding accomplishments with their poultry projects. The contributions of seven Virginia processing firms made this trip possible.

Dr. James H. Bywaters, Research Professor of Poultry Husbandry, Virginia Agricultural Experiment Station, attended the meeting of a Coordinating Committee of the Poultry Section of the Association of Southern Agricultural Workers held on January 30 at Texas Agricultural and Mechanical College, College Station, Texas. The primary purpose of the committee is to bring about closer cooperation between the folks in industry and the educational institutions. The report of this committee was accepted by the parent organization at its meeting in Dallas from February 1 through 3, and the committee was asked to continue to work.

The Virginia 4-H Poultry Judging Team composed of Sterling Mullens and Byron Childress of Dickenson County, Edry Jenkins of Gloucester County, and C. J. Martin of Franklin County, placed first in the Northeastern Interstate 4-H Poultry Judging Contest held at Boston in connection with the Boston Poultry Show, January 22. Virginia also had the two high-scoring individuals. Fred Fletcher, County Agent of Dickenson County, acted as coach and accompanied the team to the contest.

The following bulletins in the field of agriculture and home making have been issued by Virginia Polytechnic Institute:

- Extension Bul. 131 — Virginia Spray Bulletin (for orchards).
- Extension Bul. 200 — Factors for Successful 4-H Club Work.
- Extension Bul. 205 — Farm Weeds, Their Importance and Control.
- Extension Bul. 209 — What is Beautiful in Home Furnishings?
- Extension Bul. 211 — Family Washing.
- Extension Bul. 212 — Fertilizing Virginia Vegetables.
- Extension Circ. 386 — Large Yields, Better Quality Tobacco (Rev.).
- Extension Circ. 437 — Managing Your Tobacco Plant Beds (Rev.).
- Extension Circ. 598 — Your Posture — Your Voice.
- Extension Circ. 604 — Control of House Mice.
- Extension Circ. 605 — Timely Control of Garden Diseases and Insects.
- Exp. Sta. Bul. 461 — Newcastle Disease of Fowls.
- Exp. Sta. Bul. 465 — Mouse Control in Virginia Orchards.

Mr. J. O. Nicholson, who has been serving as an Instructor of Horticulture at Virginia Polytechnic Institute, has resigned to accept a position as Assistant County Agent in Coshocton County, Ohio. This appointment is effective March 1, 1954.

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Edward J. Albert, Manager of the Poultry Plant at Virginia Polytechnic Institute since December, 1924, was retired December 20, 1953 because of ill health.—WESLEY P. JUDKINS.

BACTERIOLOGY SECTION

Dr. H. J. Welshimer, Assistant Professor of Bacteriology in the Department of Microbiology at the Medical College of Virginia, has received a grant of \$5,049 from the National Institute of Health to support fundamental virus research. Dr. Welshimer's work will be concerned primarily with studies on virus adsorption and immunity of the host cells using the lysogenic bacterium-bacteriophage system as a model.

Dr. Holmes T. Knighton, Professor of Dentistry and Bacteriology in the Department of Microbiology at the Medical College of Virginia, attended the annual meeting of the Council on Dental Therapeutics of the American Dental Association held in Chicago January 22 and 23, where he presented reviews on the value of antibiotic troches in oral infections and an evaluation of alginic acids as hemostatic agents in oral conditions. Dr. Knighton is a member of the Council. — J. DOUGLAS REID.

BIOLOGY SECTION

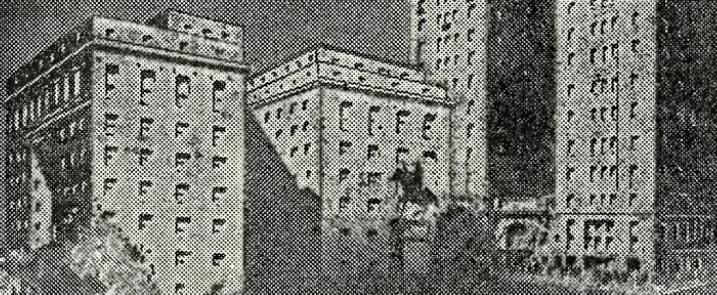
Mr. Paul M. Patterson has been granted a sabbatical leave from Hollins College for the spring semester 1954. He will collect bryophytes in selected areas of Virginia for a six-months period and study the collections after returning to Hollins. Travel expenses for the project have been made available by the Hollins College Faculty Research Fund and the National Science Foundation.

Dr. Gertrude Miller, who was awarded the doctorate by Cornell University in Botany will take over Mr. Patterson's teaching duties at Hollins while he is on leave.

Ralph Alston, 1949 graduate of William and Mary, is in his third year of graduate work at Indiana University, where he is making a chromotographic study of flower colors in *Impatiens* and investigating the biochemical bases for the inheritance of those colors. The data accumulated on the garden balsam by the late Donald W. Davis are the point of departure for Alstons' work.

Longwood College has been awarded a contract by the Atomic Energy Commission for research on the effects of combined chemical and radiation treatments on cell division and growth in the small seeded grasses. Work will be done at Longwood during the college year and at Oak Ridge during the summer months. Mr. Robert T. Brumfield will direct the research project with Mr. Donald Foard as Assistant. Mr. Foard has completed the requirements for the Masters degree majoring in Cytology at the University of Virginia and will begin work at Longwood March 1, 1954.—ROBERT T. BRUMFIELD.

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ENGINEERING SECTION

Mr. H. E. Mahony, recently manager of the Stonewall plant of Merck and Company in Elkton, Virginia, has been transferred to the Rahway, New Jersey plant as Customer Service Manager in the Marketing Division.

Professor Robert W. Truitt of the Aeronautical Engineering Department of Virginia Polytechnic Institute will serve as Director and Principal Investigator for a research program in transonic flow sponsored by the Air Research and Development Command. Professors R. W. Truitt and F. W. Martin recently attended a conference on transonic wind tunnel testing at Purdue University.

Associate Professor Dudley Thompson of the Chemical Engineering Department of Virginia Polytechnic Institute presented a paper, "The Effect of Ultrasonic Energy on the Settling of Solids in Phosphate Tailings" at a meeting of the Industrial and Engineering Chemistry Division of the American Chemical Society in Ann Arbor, Michigan, December 28 and 29, 1953. Professor Frank C. Vilbrandt was one of the co-authors of this paper.

Professor Nelson F. Murphy of the Chemical Engineering Department of Virginia Polytechnic Institute has been Director and Principal Investigator of a research project on Mass Transfer Studies in Liquid-Liquid Extraction which will be continued under the sponsorship of the Atomic Energy Commission.

Professor Dan H. Pletta of the Department of Applied Mechanics of Virginia Polytechnic Institute has been serving as Secretary of the Committee on Evaluation of Engineering Education of the American Society for Engineering Education. On February 16 to 20, 1954, he attended a meeting of this Committee in Atlanta, Georgia. Professors Dan Pletta and Dan Frederick of the Department of Applied Mechanics presented a paper entitled "Model Analysis of a Skewed Rigid Frame Bridge and Slab" at the American Concrete Institute Convention in Denver, Colorado in February, 1954. This paper is a report on research connected with the activities of the Committee on Rigid Frame Bridges of that Society. Professor Pletta is Chairman of this Committee and of the Committee on Flat Slabs.

Mr. Bernard Neimeier, formerly associated with Experiment Incorporated in Richmond, Virginia has announced the formation of his own organization under the name Faultless Engineering and Machine Corporation, also located in Richmond.

Mr. Tilton E. Shelburne, Director of the Virginia Council of Highway Investigation and Research at the University of Virginia, was elected President of the Virginia Section of the American Society of Civil Engineers at its annual meeting held in December, 1953. Mr. Shelburne has recently assumed Chairmanship of the Department of Design of the Highway Research Board, affiliated with the National Academy of Science.

Mr. Alfred Maner, formerly with the Virginia Council of Highway In-

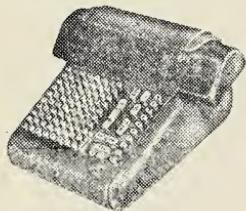
vestigation and Research in Charlottesville, has assumed the position of Assistant Testing Engineer of the Virginia Department of Highways in Richmond.

Mr. Phillip Melville, of the Virginia Council of Highway Investigation and Research in Charlottesville presented a paper at the annual meeting of the Highway Research Board in Washington during January, 1954 entitled, "Further Temperature and Moisture Characteristics of Concrete Curing Methods".

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Professors R. M. Hubbard and O. L. Updike, Jr. of the Department of Chemical Engineering of the University of Virginia attended the annual meeting of the American Chemical Society in St. Louis in December, 1953 and meetings of national committees of this Institute on which they serve.—ROBERT M. HUBBARD.

GEOLOGY SECTION

Robert S. Young, who received his Ph.D. degree in geology from Cornell University on February 1, returned to full-time duty with the State Geological Survey, as stratigrapher-structural geologist on February 16. He will in the near future begin detailed field studies of the geology and nonmetallic resources of the northern half of the Appalachian Ridge and Valley region.

Edwin O. Gooch has recently completed field work on metasedimentary rocks in the Laurel Mills-Batesville district of the central Piedmont region. Upon completion of the report on that district, he will begin a study of magnetite deposits in Carroll County.

Arthur A. Pegau is preparing a summary report on titanium in Virginia for publication as an Information Circular of the Survey.

A detailed report on the "Geology and Oil Possibilities of the Rose Hill district, L County, Virginia," by Ralph L. Miller and J. O. Fuller, is in press as Bulletin 71 of the Virginia Geological Survey. A similar report on the Geology and Oil Possibilities of the Jonesville district, Lee County, Virginia, by Raph L. Miller and Steve Brosges is being printed as United States Geological Survey Bulletin 990.

An article on "Structural Framework and Mineral Resources of the Virginia Piedmont," by William R. Brown, which is Reprint Series No. 16 of the Survey, is expected to be received soon from the State Printer.

William R. Brown, Edwin O. Gooch, and Arthur A. Pegau will present papers on *Virginia geology* at the meeting of the Southeastern Section of the Geological Society of America to be held at the University of South Carolina, in Columbia, S. C. on April 15, 16 and 17.—W. D. LOWRY.

STATISTICS SECTION

The Southern Regional Graduate Summer Session in Statistics will be held at Virginia Polytechnic Institute, June 9 through July 17, 1954. In addition to the Virginia Polytechnic Institute faculty, Professor Maurice G. Kendall, Professor Bernie G. Greenberg, and Professor Ralph E. Comstock will offer courses in Multivariate Analysis, Quantitative Genetics, and Biostatistics respectively. The following distinguished visiting statisticians will give seminar lectures: Gertrude Cox, M. G. Kendall, Ralph Comstock, W. A. Hendricks, Harold Hotelling, J. R. Stockton, H. H. Chapman, C. A. Bickling, F. J. Anscombe, W. F. Callander, R. C. Bose, B. G. Greenberg, and James W. Johnston, Jr.

A meeting of the Commission on Statistics of the Southern Regional Board of Education will meet at Virginia Polytechnic Institute on June 27, 28, 29, 30, 1954. There will be approximately 100 attending, including the leaders in statistics in the South. A number of distinguished statisticians from throughout the United States have been invited as consultants. The program will consist of discussing the training of undergraduates and graduates in statistics, research, and consulting. Part of the program will be on preparing students for statistical work in industry, and a number of leading industrialists will be called in to see what needs should be met.

The following members of the Virginia Polytechnic Institute Statistics Department will attend the joint meeting of Institute of Mathematical Statistics and Biometrics Society in Gainesville, Florida, March 16, 17, 18, 1954: Boyd Harshbarger, R. A. Bradley, D. B. Duncan, M. C. K. Tweedie, G. L. Edgett, W. A. Thompson, Jr., P. N. Somerville, C. Y. Kramer, and T. S. Russell. Boyd Harshbarger is chairman of the program committee for the Biometrics Society and R. A. Bradley is chairman of the program committee for the Institute of Mathematical Statistics. Boyd Harshbarger and D. B. Duncan will present invited papers and W. A. Thompson, Jr. will present a contributed paper.

"A Modification of the Aitken-Neville Linear Iterative Procedures for Polynomial Interpolation" by M. C. K. Tweedie of the Virginia Polytechnic Institute Statistics Department has been published in *Mathematical Tables and Other Aids to Computation*, Vol. 8, No. 45, January 1954. Reprints of the above may be obtained from the author.

Dr. Boyd Harshbarger was elected Fellow of the American Statistical

Association at the recent annual meeting in Washington, D. C. This honor was conferred for highly meritorious original contributions to statistical theory and methods and outstanding work in the organization of teaching and research in statistics.—W. A. HENDRICKS.

Virginia Academy of Science

Program

OF THE

Thirty-Second Annual Meeting

AT THE UNIVERSITY OF VIRGINIA

CHARLOTTESVILLE, VIRGINIA



May 5, 6, 7, 8, 1954

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University of Virginia

Virginia Academy of Science

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*General Program of
The Thirty-Second Annual Meeting
1954*

UNIVERSITY OF VIRGINIA
CHARLOTTESVILLE, VIRGINIA

WEDNESDAY, MAY 5

- 3:00 P.M. to 8:00 P.M. — Registration for Junior Academy Members,
Participants in the Science Talent Search — Main Lobby,
Cabell Hall.
3:00 P.M. to 8:00 P.M. — Arranging Exhibits — Cabell Hall Basement.

THURSDAY, MAY 6

- 8:00 A.M. to 5:00 P.M. — Registration for Junior Academy Members,
Senior Academy Members and Guests — Main Lobby, Cabell
Hall.
9:00 A.M. — Meeting of Science Exhibit Judges, Science Talent Search
Judges — Rooms 428, 451, Cabell Hall.
9:30 A.M. — Meeting of Chairman and Exhibitors, and Science Talent
Search Participants — Cabell Hall Auditorium.
10:00 A.M. to 12:30 P.M. and 1:30 to 4:00 P.M. — Finalists of Talent
Search meet with Chairman and Interviewers — Cabell Hall,
Rooms 428, 451, 254, 255.
10:00 A.M. to 12:30 P.M. and 1:30 to 4:00 P.M. — Judging of Science
Exhibit Contests — Cabell Hall Basement.
3:30 P.M. — Meeting of all Senior Academy Section Officers — Room
122, Cobb Chemical Laboratory.
4:00 P.M. — Meeting of the Section Editors — Room 100, Cobb Chemi-
cal Laboratory.
5:00 P.M. — Senior Academy Conference and General Meeting — Audi-
torium, Cabell Hall.
7:30 P.M. — Business Meeting, Junior Academy of Science — Audi-
torium, Cabell Hall.
8:30 P.M. — Address of Guest Speaker for Junior Academy Members
and Guests — Auditorium, Cabell Hall.
9:30 P.M. — Meeting of Virginia Junior Academy of Science Commit-
tee — Cabell Hall.

FRIDAY, MAY 7

- 8:30 A.M. — Registration — Main Lobby, Cabell Hall.
- 9:00 A.M. — Section Meetings: *Agricultural Sciences* — Room 118, Cabell Hall; *Astronomy, Mathematics, and Physics* — Rouss Physical Laboratory; *Bacteriology* — Room 311, Cabell Hall; *Biology* — Maury Hall; *Chemistry* — Room 200, Cobb Chemical Laboratory; *Education* — Room 122 Cabell Hall; *Engineering* — Room 39, Thornton Hall; *Geology* — Room 244, Cabell Hall; *Medical Sciences* — Amphitheater, Medical School; *Psychology* — Peabody Hall; *Science Teachers* — Room 122, Cobb Chemical Laboratory; *Statistics* — Room 243, Cabell Hall.
- 10:00 A.M. to 11:30 A.M. — Symposium, "What's New in Physics", sponsored by Science Teachers Section—Room 200, Cobb Chemical Laboratory (see program of Science Teachers Section).
- 12:00 Noon to 1:00 P.M. — JUNIOR-SENIOR SCIENTIST HOUR at which Awards will be presented — Auditorium, Cabell Hall.
- 2:00 P.M. — Section Meetings.
- 4:45 P.M. — 6:00 P.M. — The University of Virginia will be host at a tea to the Members and Guests of the Academy—Rotunda.
- 7:45 P.M. — Short Business Meeting, Senior Academy — Auditorium, Cabell Hall.
- 8:30 P.M. — Address by Dr. J. A. Becker, Bell Telephone Laboratories, "Seeing and Counting Atoms" with the New Field Emission Microscope" — Auditorium, Cabell Hall.

SATURDAY, MAY 8

- 9:00 A.M. — Section Meetings.
- 10:00 A.M. — Academy Council Meeting — Conference Room, Cobb Chemical Laboratory.

*Program of
Virginia Junior Academy of Science*

WEDNESDAY, MAY 5

- 3:00 P.M. to 9:00 P.M. — Registration for Junior Academy Members,
Participants in the Science Talent Search.
3:00 P.M. to 9:00 P.M. — Arranging Exhibits.
8:30 P.M. to 10:30 P.M. — A Visit to the Observatory.

THURSDAY, MAY 6

- 8:00 A.M. to 5:00 P.M. — Registration for Juniors.
9:00 A.M. — Meeting of Science Exhibit Judges and Science Talent
Search Judges.
9:30 A.M. — Meeting of Chairman, Exhibitors, and Science Talent
Search Participants.
10:00 A.M. to 12:00 P.M. — Finalists of Talent Search meet with Chair-
man and Interviewers.
10:00 A.M.-12:30 P.M. — Judging of Science Exhibits.
1:30 P.M. to 4:00 P.M. — Continuation of Interviews of Finalists.
1:30 P.M. to 4:00 P.M. — Continuation of Judging Exhibits.
7:30 P.M. — Business Meeting of the Junior Academy of Science.
8:30 P.M. — Address of Guest Speaker.
9:30 P.M. — Meeting of Virginia Junior Academy of Science Committee.

FRIDAY, MAY 7

- 8:30 A.M. — Meeting of 40 Selected Junior Scientists (who will have
40 Senior Scientists as their companions until 12:00 noon).
9:00 A.M. — Section Meetings.
12:00-1:00 P.M. — JUNIOR-SENIOR SCIENTIST HOUR *at which awards will
be presented.*

Section of Agricultural Sciences

H. MARSHALL CLARK, *Chairman*

RODNEY C. BERRY, *Vice-Chairman*

R. W. ENGEL, *Secretary*

WESLEY P. JUDKINS, *Section Editor (1956)*

FRIDAY, MAY 7, 1954 — 9:00 A.M. — ROOM 118, CABELL HALL

- 9:00 Announcements, Committee appointments, etc.
1. 9:15 The Relationship of Browse to Deer Weights in Bath County, Virginia.
R. J. Muncy; *Virginia Agricultural Experiment Station*.
2. 9:30 Ecological Succession in Cumberland County, Virginia.
M. A. Byrd; *Virginia Agricultural Experiment Station*.
3. 9:45 Rabies in Virginia and Its Economic Effect on Agriculture.
John C. Jones; *Mammal Control Supervisor, Fish and Wildlife Service, Department of Interior*.
4. 10:15 The Production of Bovine Hyperkeratosis (X-disease) with an Experimentally Made Pellet Feed.
J. S. Copenhaver and W. B. Bell; *Virginia Agricultural Experiment Station*.
5. 10:30 Rumen Inoculation of Beef Calves.
F. S. McClaugherty and C. M. Kincaid; *Virginia Agricultural Experiment Station*.
6. 10:45 Testing Performance of Beef Cattle on the Farm.
J. E. Grizzle, C. M. Kincaid, and C. C. Mast; *Virginia Agricultural Experiment Station*.
7. 11:00 Variations in Gestation Periods of Dairy Cattle.
Paul M. Reaves; *Virginia Agricultural Experiment Station*.
8. 11:15 Substitution Relationships Between Grain and Forage in Milk Production.
Carl W. Allen; *Virginia Agricultural Experiment Station*.
9. 11:30 Correlation Between Blood Levels of Carotene and Vitamin E in Dairy Cows in Selected Herds in Virginia.
W. N. Linkous, N. O. Price, W. B. Bell, W. A. Hardison, and R. W. Engel; *Virginia Agricultural Experiment Station cooperating with the Virginia Artificial Breeder's Association*.
- 12:00 Noon-1:00 P. M. — Junior-Senior Scientist Hour — Auditorium, Cabell Hall.

FRIDAY, MAY 7, 1954 — 1:30 P.M.

10. 1:30 Problems in the Correlation of Soil Testing with Crop Response in Virginia.
Russell K. Stivers and C. I. Rich; *Virginia Agricultural Experiment Station*.
11. 1:45 Trends in Agricultural Chemicals.
Borden S. Chronister; *Nitrogen Division, Allied Chemical and Dye Corporation, Hopewell*.
12. 2:00 Studies of the Parasitism of *Cercospora arachidicola* Hori and *Cercospora personata* (B. and C.) Ell. and Ev.
Lawrence I. Miller; *Virginia Agricultural Experiment Station*.
13. 2:15 Weather Influences on Evaporation.
Joseph M. Johnson; *Virginia Agricultural Experiment Station*.
14. 2:30 Herbicides and Their Importance in Today's Agriculture.
W. E. Chappell; *Virginia Agricultural Experiment Station*.
15. 2:45 The Bromide Content of Peanut Plants from Soil Treated with Ethylene Dibromide for Sting Nematode Control.
R. W. Young, L. I. Miller, and R. W. Engel; *Virginia Agricultural Experiment Station*.
16. 3:00 The Nature of Insect Resistance to Chemical Poisons.
James McD. Grayson; *Virginia Agricultural Experiment Station*.
17. 3:15 An Improved Procedure for the Direct Isolation of Cellulolytic Rumen Bacteria.
Paul H. Smith and K. W. King; *Virginia Polytechnic Institute*.
18. 3:30 Refinements in Plate Counting Procedures for Cellulose Decomposing Soil Microorganisms.
J. D. Castro and K. W. King; *Virginia Polytechnic Institute*.
- 3:45 Business Meeting.

***Section of
Astronomy, Mathematics, and Physics***

L. W. WEBB, JR., *Chairman*

H. Y. LOH, *Secretary*

I. G. FOSTER, *Section Editor (1956)*

FRIDAY, MAY 7, 1954 — 10:00 A.M. — ROUSS PHYSICAL LAB.

1. 10:00 Application of the Power Series Transform to Difference Equations in Engineering.
Leonard McFadden; *Virginia Polytechnic Institute.*
 2. 10:15 The Differentiation of Lebesgue Integrals.
E. J. McShane; *University of Virginia.*
 3. 10:30 Methods of Spinning Rotors at Liquid Helium Temperatures.
Jesse W. Beams; *University of Virginia.*
 4. 10:45 The Measurement of Tensile Strength of Metals at Low Temperature.
John B. Breazeale; *University of Virginia.*
 5. 11:00 Adsorption and Surface Energy.
N. Cabrera; *University of Virginia.*
 6. 11:15 Neutron Interactions in Organic Scintillators.
Roger W. Clapp and Robert T. Wagner; *University of Virginia.*
 7. 11:30 Measurement of Molecular Weights by the Equilibrium Method.
H. M. Dixon; *University of Virginia.*
 8. 11:45 The Effect of a Centrifugal Field on Diffusion in Metals.
Orville R. Harris; *University of Virginia.*
- 12:00 Noon-1:00 P.M. — Junior-Senior Scientist Hour — Auditorium, Campbell Hall.

FRIDAY, MAY 7, 1954 — 2:00 P.M.

- 2:00 Business Meeting.
9. 2:15 Positron Annihilation in Liquid Helium.
Frank L. Hereford; *University of Virginia.*
10. 2:30 The Magnetic Microbalance.
Charles W. Hulbert; *University of Virginia.*
11. 2:45 Lattice Summations in Crystals and Energy of Twin Boundaries.
M. Levine; *University of Virginia.*
12. 3:00 Dispersion of Thin Lamina.
H. Y. Loh; *Virginia Polytechnic Institute.*
13. 3:15 Angular Distribution of Photoelectrons Produced by Polarized Gamma-rays.
William M. McMaster and Frank L. Hereford; *University of Virginia.*
14. 3:30 An Inexpensive Device for Measuring X-Ray Powder Diffraction Patterns.
W. Richardson; *Virginia Polytechnic Institute.*

15. 3:45 An X-Ray Diffraction Machine Assembled Almost Entirely from War Surplus Parts.
James Scott, R. K. Brown, and W. Richardson; *Virginia Polytechnic Institute.*
16. 4:00 Mechanical Strength of Thin Films of Metals.
Edward F. Turner; *University of Virginia.*
17. 4:15 Commentary on Locating and Constructing the Image of a Virtual Object.
H. D. Ussery, *Virginia Polytechnic Institute.*
18. 4:30 The Measurement of Gyro-magnetic Ratios by a New Method.
Glen S. Waterman; *University of Virginia.*

SATURDAY, MAY 8, 1954 — 9:00 A.M.

19. 9:00 Visual Orbit of Mu Orionis.
Harold L. Alden; *University of Virginia.*
20. 9:15 Photometry of Red Dwarfs.
George S. Mumford, III; *University of Virginia.* (Introduced by A. N. Vyssotsky.)
21. 9:30 The Unusual Variable Star EZ Aquilae.
Charles P. Olivier; *Flower and Cook Observatories, University of Pennsylvania.*
22. 9:45 Astrometric Orbit and Mass Ratio of Mu Orionis.
V. Osvalds; *Leander McCormick Observatory.* (Introduced by H. L. Alden.)
23. 10:00 A Bibliography of Spirals.
Georgie T. Davis and D. S. Davis; *Virginia Polytechnic Institute.*
24. 10:15 Some Relationships Concerning Neo-Pythagorean Triangles.
Herta Taussig Freitag, *Hollins College*, and Arthur H. Freitag, *Jefferson Senior High School, Roanoke.*
25. 10:30 A Brief Method for Transforming Recurring Decimal-Fractions to Mixed Numbers.
Herta Taussig Freitag, *Hollins College*, and Arthur H. Freitag, *Jefferson Senior High School, Roanoke.*
26. 10:45 Ionization in Flames.
I. R. King and H. F. Calcote; *Experiment Incorporated, Richmond.*
27. 11:00 A Set of Lecture Demonstrations.
L. G. Hoxton; *University of Virginia.*

Section of Bacteriology

P. ARNE HANSEN, *Chairman*

H. J. WELSHIMER, *Vice-chairman*

WILLIAM F. LAWRENCE, *Secretary*

J. DOUGLAS REID, *Section Editor*

SATURDAY, MAY 8, 1954 — 11:00 A.M. — ROOM 311, CABELL HALL

11:00 Business Meeting.

SATURDAY, MAY 8, 1954 — 1:30 P.M.

1. 1:30 Studies on the Metabolism of Propionic Bacteria.
Wesley A. Volk; *University of Virginia*.
2. 1:45 Comparative Bactericidal Effects of Moist and Dry Heat on Certain Nonsporogenous Bacteria.
H. K. Knighton; *Medical College of Virginia*.
3. 2:00 An Example of Multisporogenous Bacterium.
H. J. Welshimer; *Medical College of Virginia*.
4. 2:15 Respiration of *Mycobacterium paratuberculosis*.
Robert H. Miller and P. Arne Hansen; *Department of Bacteriology and the Live Stock Sanitary Service Laboratory, University of Maryland*.
5. 2:30 The Tuberculostatic Properties of Ascorbic Acid.
Quentin N. Myrvik; *University of Virginia*.
6. 2:45 Some Environmental Factors in the Cultivation of *Endamoeba histolytica*.
E. Clifford Nelson and Muriel Jones; *Medical College of Virginia*.
7. 3:00 Electrophoretic Behavior of *Salmonella pullorum*.
Shelley Harrell and P. Arne Hansen; *Department of Bacteriology and the Live Stock Sanitary Service Laboratory, University of Maryland*.
8. 3:15 Viral Hepatitis in Mice.
Michael Potter; *University of Virginia*.
9. 3:30 Some Experiments with the Molecular Filter Membrane Technique and Demonstrations of the Apparatus.
R. Travis Hill; *Virginia State Department of Health*.
10. 3:45 Development, Use, and Effectiveness of BCG Vaccine.
William F. Wagner; *Virginia State Department of Health*.

Section of Biology

ZOE WELLS CARROLL BLACK, *Chairman*

VERA B. REMSBURG, *Vice-Chairman*

KENNETH P. STEVENS, *Secretary*

ROBERT T. BRUMFIELD, *Section Editor (1957)*

FRIDAY, MAY 7, 1954 — 9:00 A.M. — MAURY HALL

9:00 Announcement, Committee Reports.

1. 9:10 Notes on the Nutrition of Three Species of *Arcella*.
John E. Davis, Jr.; *University of Virginia*.
2. 9:20 Morphological Observations on *Cambarincola* Sp. (Annelida, Oligochaeta).
Benjamin Irving Johns; *University of Virginia*.
3. 9:30 Stain Technique and Observations from a Preliminary Study of Megagametogenesis in *Ilex opaca*.
John M. Herr, Jr.; *Washington and Lee University*.
4. 9:45 The X-bivalent of the Golden Hamster
Charles I. Sheaffer; *University of Virginia*.
5. 9:55 Comparison of Certain Developmental Features of the Fibro-follicles of Sheep and Goats.
Lubow A. Margolena; *U. S. Department of Agriculture*.
6. 10:05 Chromosomes of Representatives of Alismataceae in Gray's Manual Range.
J. T. Baldwin, Jr. and Bernice M. Speese; *College of William and Mary*.
7. 10:15 A Study of Normal and Aberrant Meiosis in Oocytes of the Newt, *Triturus viridescens*.
Asa A. Humphries, Jr.; *University of Virginia Medical School*. (To be introduced)
8. 10:30 Ecology of the Red Cedar, *Juniperus virginiana*.
A. B. Massey; *Virginia Polytechnic Institute*.
9. 10:40 Notes on the Evolution of the Longulus Group of the Crayfish Genus *Cambarus*.
Horton H. Hobbs, Jr.; *University of Virginia*.
10. 10:50 Sulfur Nutrition and the Amino Acid Composition of Fur in Relation to the Fur-chewing Syndrome in Domestic Chinchillas.
C. O. Watlington, J. P. Baker, and K. W. King; *Virginia Polytechnic Institute* (Presented by C. O. Watlington)

- 11:00 Business Meeting.
- 12:00 Noon-1:00 P.M. — Junior-Senior Scientist Hour — Auditorium, Campbell Hall.

FRIDAY, MAY 7 — 1:30 P.M.

11. 1:30 Physiology of Diapause in the Grasshopper Embryo, Studied by a New Method of *in Vitro* Culture for Insect Embryos.
Donald H. Bucklin; *College of William and Mary*.
12. 1:40 The Sodium and Potassium Ion Change in the Blood of Hibernating Hamsters.
Lucy Byrd Pegau; *University of Virginia*.
13. 1:50 Studies of Oxygen Capacity in Relation to Sex.
Jack D. Burke; *University of Richmond*.
14. 2:00 An Investigation to Establish the Viability Expectancy of Bullets of Wild Onion and Garlic *Allium SPP*. Occurring in Field Crop Seed, Based on Size and Physiological Classifications.
C. M. Bass; *Virginia Department of Agriculture*.
15. 2:10 Observations on the Circulation of the Kidney of *Rana catesbeiana*.
E. W. Pullen and H. H. Hobbs; *University of Virginia*.
(Presented by E. W. Pullen.)
16. 2:20 Temperature and Moisture in the Ecology of Earthworms.
William C. Grant, Jr.; *College of William and Mary*.
17. 2:30 Genetics of Chlordane Resistance in the German Cockroach. Progress Report.
F. E. Jarvis, Jr., J. M. Grayson, and M. Levitan; *Virginia Polytechnic Institute*. (Presented by F. E. Jarvis.)
18. 2:40 Observation on the Mayfly Fauna in an Upper Piedmont Stream in Central Virginia.
Jean E. Pugh; *University of Virginia*.
19. 2:50 A Polarographic Study of Respiration in a Blue-Green Alga.
S. L. Coke, Jr.; *University of Richmond*.
20. 3:00 Morphogenetic Studies on the Subterranean Axes of *Psilotum nudum*.
David W. Bierhorst; *University of Virginia*.
21. 3:10 Abnormal Ovule Development in *Ilex opaca*.
John M. Herr, Jr.; *Washington and Lee University*.
22. 3:20 Observations on the Effects of Some Supposedly Toxic Substances on Ephemeropteran Nymphs.
James L. Larimer; *University of Virginia*.

Chemistry Section

ROBERT C. KRUG, *Chairman*

J. STANTON PIERCE, *Secretary*

CARL J. LIKES, *Section Editor (1957)*

FRIDAY, MAY 7 — 9:00 A.M.—ROOM 200—COBB CHEMICAL LAB.

- 9:00 Introductory Remarks of the Chairman.
1. 9:05 Studies on the Mechanism of High Temperature Antioxidants.
James W. Cole, Jr., Lewis G. Cochran, Gordon P. Brown,
and Miron F. Johnson, Jr.; *University of Virginia*.
2. 9:20 The Oxidation of a Single Crystal of Iron.
Bruce Wagner, Jr.; *University of Virginia*.
3. 9:40 The Structure of Oxide Films on Copper Single Crystals.
Kenneth R. Lawless; *University of Virginia*.
4. 9:55 The Effect of Contaminants on the Oxidation of Copper
Single Crystals.
Kenneth R. Lawless; *University of Virginia*.
5. 10:10 The Influence of Foreign Atoms on the Catalytic Properties
and Surface Structure of Metal Single Crystals.
Robert E. Cunningham; *University of Virginia*.
6. 10:35 Studies of the Chemical Properties of Single Crystals of
Silver Chloride.
Frances H. Cook; *Virginia Institute for Scientific Research*.
7. 10:50 Applications of the Field Emission Microscope.
Peter B. Sherry; *University of Virginia*.
8. 11:05 The Adsorption of Organic Poisons on the Hydrogen Electrode.
Thomas C. Franklin and Phillip Oglesby; *University of Richmond*.
9. 11:15 An Industrial Chemist Looks at Farming (Guest Lecture).
Robert H. Kean; *Virginia-Carolina Chemical Corp.*
- 12:00 Noon-1:00 P.M. — Junior-Senior Scientist Hour — Auditorium,
Cabell Hall.

FRIDAY, MAY 7 — 1:45 P.M.

10. 1:45 Effect of Solute Concentration on Surface and Interfacial
Tensions of Several Liquid Systems.
John E. Lastovica and Nelson F. Murphy; *Virginia Polytechnic Institute*.

11. 2:00 Ultraviolet Absorption of Chalcones.
W. Bruce Black and Robert E. Lutz; *University of Virginia.*
12. 2:15 Ring-Chain Relationships in the 2-(N-Acetal-N-benzylamino)-1,2-diphenylethanone and Ethanol Series. The Mechanism of Cyclo-trans-Etherification.
Claibourne E. Griffin and Robert E. Lutz; *University of Virginia.*
13. 2:30 The Preparation of Dialkyl Zinc Compounds.
Robert C. Krug and Philip J. C. Tang; *Virginia Polytechnic Institute.*
14. 2:40 Structural Effects in the Kinetics of Schiff Base Formation.
Richard L. Hill and Thomas I. Crowell; *University of Virginia.*
- 2:55 Announcement of Talent Search Winners in Chemistry.
15. 3:00 A Study of the Reaction Between o-Chlorobenzyl Chloride and Naphthalene.
Frank A. Vingiello and Alexej Borkovec; *Virginia Polytechnic Institute.*
16. 3:10 B-Tetrahydro- and Decahydroquinolinylethanol as Intermediates.
Charles J. Hansrote, Jr., Y. H. Chen, and J. Stanton Pierce; *University of Richmond.*
17. 3:20 Some Consideration of the Occurrence and Structure of Phosphate Minerals.
D. S. Sears; *Virginia-Carolina Chemical Corp.*
18. 3:35 Studies on *O, O, O-Trialkyl Phosphorothioates.*
C. L. Harowitz, C. E. Setliff, and J. R. Mangham; *Virginia-Carolina Chemical Corp.*
19. 3:45 The Preparation of Some Alkylphosphoric Amides.
J. R. Mangham and T. M. Melton; *Virginia-Carolina Chemical Corp.*
20. 4:00 The Fungitoxicity of Nicotine and Nicotine Derivatives.
Lewis E. Govette; *Virginia-Carolina Chemical Corp.*
21. 4:15 A Laboratory Method for the Evaluation of Organic Phosphorus Compounds for Insecticidal Activity.
M. A. Manzelli and V. H. Young; *Virginia-Carolina Chemical Corp.*
- 4:30 Adjourn.

SATURDAY, MAY 8 - 9:00 A.M.

- . 22. 9:00 Molecular Dimensions of Zein.
Carl J. Likes; *Virginia Institute for Scientific Research.*
23. 9:10 Anisotropic Swelling of Zein Fibers.
George L. Walker, Jr. and J. Samuel Gillespie, Jr.; *Virginia-Carolina Chemical Corp.*
24. 9:20 Correlation of Molecular Weight-Distribution Data for High Polymers.
D. W. Levi and D. S. Davis; *Virginia Polytechnic Institute.*
25. 9:30 Chemistry of Clorene.
Albert W. Lutz; *College of William and Mary.*
26. 9:40 Reduction Products of Aromatic Nitro Compounds Using Silicon-Sodium Hydroxide.
Ira A. Updike and Edward C. Wilson; *Randolph-Macon College.*
27. 9:50 The Effect of the Medium on the Thiosulfate-Ethyl Bromide Reaction.
Francis B. Clough, Thomas S. Russell, and J. C. Salonish; *Virginia Polytechnic Institute.*
28. 10:05 Some Modern Aspects of Urinary Calculi in Relation to Dissolution by Enzymes.
Lawrence W. Claffey, David Levi, and S. Ford; *Virginia Polytechnic Institute.*
29. 10:15 A New Reagent for the Colorimetric Determination of Traces of Magnesium.
Charles K. Mann and John H. Yoe; *University of Virginia.*
30. 10:30 Colorimetric Determination of Boron with Tetrabromochrysazin.
Robert L. Grob and John H. Yoe; *University of Virginia.*
31. 10:45 Potentiometric Microdetermination of Halogen in Organic Compounds.
Everett C. Cogbill and J. Jack Kirkland; *University of Virginia.*
32. 11:00 A Study of Spectrophotometric Methods for the Determination of Trace Quantities of Boron.
James E. Hardcastle, Emmett H. Poindexter and W. Allan Powell; *University of Richmond.*
33. 11:10 Influence of the Cyclopropyl Group on the Stability of Copper Chelates of 1,3-Dicarbonyl Compounds.
Barbara Ann Braun and Helen L. Whidden; *Randolph-Macon Woman's College.*

34. 11:25 A Progress Report on the Study of Coordination Compounds of Polyhydroxyamines.
William E. Trout, Jr., J. Stanton Pierce and Jane Bell Gladding; *University of Richmond*.
35. 11:35 Factors Influencing Chelate Formation.
Maxwell L. Cluett; *University of Virginia*.
36. 11:50 Electrical Conductivity of Some Molten Salts.
O. L. Updike, Jr. and L. B. Johnson, Jr.; *University of Virginia*.
- 12:00 Adjourn.

Section of Engineering

ROBERT W. TRUITT, *Chairman*

PHILLIP L. MELVILLE, *Secretary*

ROBERT M. HUBBARD, *Section Editor (1958)*

FRIDAY, MAY 7, 1954 — 9:00 A.M. — ROOM 39, THORNTON HALL

- 9:00 Announcements.
1. 9:15 Road Roughness Measurements on Virginia Pavements.
Thomas H. Forrer; *Virginia Council of Highway Investigation and Research*.
2. 9:30 An Automatic Tuning Band Pass Filter.
Harry L. Beazell; *University of Virginia*.
3. 9:45 Organization of Mechanical Designs.
B. A. Niemeier; *Faultless Engineering and Machine Corporation, Richmond, Va.*
4. 10:00 Pressure Distribution on Two Dimensional Bodies in a Non Uniform Free Stream.
Joseph Hendricks; *Virginia Polytechnic Institute*.
5. 10:15 P-V-T Relationships for Trichloromonofluoromethane.
Robert L. Brehm and D. S. Davis; *Virginia Polytechnic Institute*.
6. 10:30 Transient Responses of Non Linear Systems.
A. F. Lampros; *Virginia Polytechnic Institute*.
7. 10:45 Investigation of Pressure Distribution on a 180° Wedge.
R. W. Truitt and J. C. Williams III; *Virginia Polytechnic Institute*.
8. 11:00 Skid Tests for Safety.
A. W. Maner; *Virginia Department of Highways*.

9. 11:15 Some Problems of Elastic Beams Resting on a Foundation Including Effect of Shear and Normal Pressure.
D. Frederick and F. Blottner; *Virginia Polytechnic Institute.*
10. 11:30 Model Studies of Pile Foundations Subject to Lateral Loading.
R. K. L. Wen; *Virginia Council of Highway Investigation and Research.*
11. 11:45 Guided Missile Airframe Responses.
C. D. West; *McDonnell Aircraft Co., St. Louis, Mo.*
- 12:00 Noon-1:00 P.M. — Junior-Senior Scientist Hour — Auditorium, Cabell Hall.
12. 2:00 Reveries of An Engineer.
W. R. Glidden; *Virginia Department of Highways.*
13. 2:30 Structural Applications of Aluminum Alloys.
Charles Gaylord; *University of Virginia.*
14. 2:45 Some Fundamental Theorems on Similar and Dissimilar Elastic Models.
D. Frederick; *Virginia Polytechnic Institute.*
15. 3:00 Thermal Anisotropy and Conductivity of Nylon 66.
Arthur C. Doumas and Robert A. Fisher; *Virginia Polytechnic Institute.*
16. 3:15 The Construction of Influence Lines with a Mechanical Interferometer.
James H. Sword; *Virginia Polytechnic Institute.*
17. 3:30 Flow Visualization by Schlieren Techniques for Mixing Studies.
Barbour B. Wilson and O. L. Updike, Jr.; *University of Virginia.*
18. 3:45 An Investigation of Furnace Wall Heat Losses.
F. Anthony Iachetta; *University of Virginia.*
- 4:00 Business Meeting.

SATURDAY, MAY 8, 1954 -- 9:00 A.M.

19. 9:00 An Instrument for Recording the Earth's Electric Field.
Robert F. Fleming, Jr.; *University of Virginia.*
20. 9:15 Extraction and Evaluation of Tobacco Seed Oil.
Robert A. Fisher; *Virginia Polytechnic Institute.*
21. 9:30 Effects of Ultrasonic Insonation on Solvent Extraction of Oil from Peanuts.
Dudley Thompson and D. G. Sutherland; *Virginia Polytechnic Institute.*

22. 9:45 Pressure Distribution About Diamond Airfoils in a Two Dimensional Incompressible Flow.
F. W. Martin; *Virginia Polytechnic Institute.*
23. 10:00 Principal Stress Gradients in Gear Teeth.
E. D. Harrison; *Virginia Polytechnic Institute.*
24. 10:15 COUNTERCURRENT FLOW OF TWO PHASE LIQUID-LIQUID SYSTEMS.
Nelson F. Murphy and John E. Lastovica, Jr.; *Virginia Polytechnic Institute.*
25. 10:30 Effect of 400 Kilocycle Insonation on the Extraction of Aceton from Carbon Tetrachloride with Water.
Dudley Thompson and L. P. Murray, Jr.; *Virginia Polytechnic Institute.*
26. 10:45 Low Cost Study of Supersonic Flow.
D. P. Lalor, James May, and E. C. McClintock; *University of Virginia.*
27. 11:00 Effect of Seed Structure on the Solvent Extraction of Oil from Tobacco Seed.
Jesse M. Carr, Jr. and Robert A. Fisher; *Virginia Polytechnic Institute.*

Section of Geology

WAYNE E. MOORE, *Chairman*

WILLIAM T. HARNISBERGER, *Vice-Chairman*

MARCELLUS H. STOW, *Secretary*

W. D. LOWRY, *Section Editor (1958)*

FRIDAY, MAY 7, 1954 — 9:00 A.M. — ROOM 303, BROOKS MUSEUM

1. 9:00 Some Current Projects of the Virginia Geological Survey.
William M. McGill; *Virginia Geological Survey.*
2. 9:10 Infolded Metasediments Near the Axial Zone of the Catoctin Mountain — Blue Ridge Anticlinorium.
Edwin O. Gooch; *Virginia Geological Survey.* (Introduced by William M. McGill.)
3. 9:25 Occurrence of Red Limestone in the Ordovician, Augusta County, Virginia.
R. S. Edmundson; *University of Virginia.*
4. 9:35 Arthropycus as a Guide Fossil in Northern Virginia.
Robert S. Young; *Virginia Geological Survey.* (Introduced by William M. McGill.)

5. 9:45 Geological Section Along Roanoke River from Clarksville, Virginia to Roanoke Rapids, North Carolina.
Wilbur A. Nelson; *University of Virginia.*
6. 9:55 Display of Scintillometer, Geiger Counters, and Ultraviolet Lamps.
Marcellus H. Stow; *Washington and Lee University.*
7. 10:00 Geology of Uranium Deposits with Special Reference to the Geology of Virginia.
Donald L. Everhart; *Chief, Geological Branch, Raw Materials Division, U. S. Atomic Energy Commission.* (Introduced by Marcellus H. Stow.)
8. 10:25 The Master's Degree in Geology.
Joseph K. Roberts; *University of Virginia.*
9. 10:35 Studies of Stream Profiles in the Shenandoah Valley, Virginia.
John T. Hack; *U. S. Geological Survey.* (Introduced by Marcellus H. Stow.)
10. 10:50 Soil Mineralogical Studies in the Middle River Basin, Virginia.
Dorothy Carroll; *U. S. Geological Survey.* (Introduced by Marcellus H. Stow.)
11. 11:05 Investigations of Alluvial Clays in the Shenandoah Valley, Virginia.
John C. Hathaway; *U. S. Geological Survey.* (Introduced by Marcellus H. Stow.)
- 11:20 Announcements.
- 12:00 Noon-1:00 P.M. — Junior-Senior Scientist Hour — Auditorium, Cabell Hall.

FRIDAY, MAY 7, 1954 — 2:00 P.M.

12. 2:00 Clay Minerals in Tatum Silt Loam Soil.
C. I. Rich; *Virginia Agricultural Experiment Station.*
13. 2:15 Subsurface Drainage Along North Side of Walker Mountain, Virginia.
Jean Lowry; *Virginia Geological Survey.*
- 2:20-3:05 Symposium on Dolomites.
14. 2:20 Fundamental Aspects of Genesis of Appalachian Dolomites.
B. N. Cooper; *Virginia Polytechnic Institute.*
15. 2:30 Staining Methods for Differentiating Limestones and Dolomites.
C. R. B. Hobbs, Jr.; *Virginia Polytechnic Institute.* (Introduced by B. N. Cooper.)

16. 2:40 Selective Obliteration of Fossils by Dolomitization.
W. E. Moore; *Virginia Polytechnic Institute.*
17. 2:45 Pre-lithification Features of Some Appalachian Dolomites.
W. D. Lowry; *Virginia Polytechnic Institute.*
18. 2:55 Possible Trace-element and Isotope Control of Dolomite Formation.
R. V. Dietrich; *Virginia Polytechnic Institute.*
19. 3:05 Deposition of Calcite and Aragonite in Caves.
J. W. Murray; *Virginia Polytechnic Institute.* (Introduced by Wayne E. Moore.)
20. 3:20 Geology of Austinville District, Wythe County, Virginia.
W. Horatio Brown; *New Jersey Zinc Company.*
21. 3:35 Magnetic and Electrical Resistivity Survey of the Bush-Hutchins Ilmenite Prospect, Vinton, Virginia.
Charles E. Sears, Jr.; *Virginia Polytechnic Institute.*
22. 3:50 A Review of Recent Literature on the Geology and Origin of Pegmatites.
Arthur A. Pegau; *Virginia Geological Survey.*
23. 4:00 Exploratory Driling on the Eastern Shore Peninsula, Virginia.
G. Chase Tibbitts, Jr.; *U. S. Geological Survey.* (Introduced by Allen Sinnott.)
24. 4:05 Heavy Minerals of Some Yorktown (Miocene) Sediments of Virginia.
Joseph S. Laurent, David W. McCain, Albert J. Perry; *Washington and Lee University.* (Presented by Albert J. Perry.)
25. 4:15 Mineral Studies of the Product of Some Virginia Quarries.
Bertram S. Griffith, Jr., Eugene B. Sieminski, Mahlon D. Woodring; *Washington and Lee University.* (Presented by Eugene B. Sieminski.)
26. 4:25 Note on the Four Types of Crustal Megashearing in Virginia.
B. Ashton Keith; *The Institute of Sciences.*
- 4:40 Business Meeting.

SATURDAY, MAY 8, 1954 — 8:00 A.M.

- 8:00 Field Trip to Triassic Areas.
Leader: Joseph K. Roberts. (Place of assembling and details of trip to be announced during Friday meeting.)

Section of Medical Sciences

D. R. H. GOURLEY, *Chairman*

SIDNEY SOLOMON, *Secretary*

EBBE C. HOFF, *Section Editor (1954)*

FRIDAY, MAY 7, 1954 — 9:30 A.M. — MEDICAL SCHOOL

AUDITORIUM

1. 9:30 Motion Pictures Showing Nerve Growth and Other Cell Activities in Tissue Culture of Retina and Brain from Frog and Rat.
Carl C. Speidel; *University of Virginia Medical School.*
 2. 9:45 The Presence of Argentophilic Cells in the Human Adenohypophysis.
William M. Shanklin; *Medical College of Virginia.*
 3. 10:00 Effects of Hormones on Serum Protein Patterns.
Cornelia Hoch-Ligeti and Karen Irvine; *University of Virginia Medical School.*
 4. 10:15 Chemical and Ultracentrifugal Lipid Analysis of Diabetic and Cardiac Sera.
D. F. Koenig, P. D. Camp, W. R. Jordan, J. C. Forbes, and C. J. Likes; *Virginia Institute for Scientific Research.*
 5. 10:30 The Role of Adrenal Glands in the Support of Arterial Blood Pressure in Dogs and Cats Following Extensive Surgery.
E. D. Brand; *University of Virginia Medical School.*
 6. 10:45 A Theory of Thyroxine Action.
Chalmers L. Gemmill; *University of Virginia Medical School.*
 7. 11:00 Effect of Alcohol and ACTH on Liver Ascorbic Acid in the Guinea Pig.
J. C. Forbes and G. M. Duncan; *Medical College of Virginia and The Division of Alcoholic Studies and Rehabilitation, Dept. of Health, State of Virginia.*
 8. 11:15 Blood and Urinary Changes During Acute Alcohol Intoxication in Dogs.
Cerda I. Klingman, Ruby Bane, Harry Bachman, and Harvey Haag; *Medical College of Virginia.*
- 11:30 Business Meeting.
- 12:00 Noon-1:00 P.M. — Junior-Senior Scientist Hour — Auditorium, Cabell Hall.

FRIDAY, MAY 7, 1954 — 1:30 P.M.

9. 1:30 Sedative Hypnotic Properties of 2-ethyl-crotonyl urea.
Merle H. Pindell, Otis E. Fancher, and Robert K. S. Lim;
Miles-Ames Research Laboratory.
10. 1:45 Sacro-Coccygeal Tumor.
J. E. Kindred; *University of Virginia Medical School.*
11. 2:00 The Use of a Persistent Screen Oscilloscope for the Accurate Measurement of Seizure Threshold in Rats.
Cary G. Suter, Guy C. Heye, Jr., and Thomas H. Simmons, Jr.; *University of Virginia Hospital.*
12. 2:15 Studies on Pancreatic Trans-membrane Potentials.
S. Solomon; *Medical College of Virginia.*
13. 2:30 Effects of Adenosine Triphosphate, Magnesium, and Calcium on the Phosphate Uptake by Rabbit Erythrocytes.
H. Jonas; *University of Virginia Medical School.*
14. 2:45 Potassium Adsorption by Epithelial Cells of Isolated Frog Skin.
E. G. Huf and J. P. Wills; *Medical College of Virginia.*
15. 3:00 Inhibition of *In Vitro* Heme Synthesis from N¹⁵ Glycine by 2, 5-Dimethylbenzimidazol, 5, 6 Dimethylbenzimidazol, and Related Compounds.
Lynn D. Abbot, Jr. and Mary J. Dodson; *Medical College of Virginia.*
16. 3:15 *In Vitro* Measurement of Potassium Turnover in Rat Skeletal Muscle.
D. R. H. Gourley; *University of Virginia Medical School.*
17. 3:30 Studies on the Metachromatic Reaction of Heparin-like Substances.
John Kelly; *Medical College of Virginia.*
18. 3:45 A Simple Method for the Determination of Azo Dyes in Tissues.
C. C. Clayton; *Medical College of Virginia.*
19. 4:00 Influence of Cortisone on the Mortality of X-Irradiated Adrenalectomized Mice.
George A. Santisteban; *Medical College of Virginia.*
20. 4:15 Bovine Leptospiral Meningitis and Uveitis.
Warren G. Hoag and Wilson P. Bell; *Virginia Agricultural Experiment Station.*

Section of Psychology

STANLEY B. WILLIAMS, *Chairman*

HANNAH S. DAVIS, *Secretary-Treasurer*

REUBEN S. HORLICK, *Executive Committeeman*

RICHARD H. HENNEMAN, *Section Editor*

FRIDAY, MAY 7, 1954

CLINICAL SECTION — 9:00 A.M. — ROOM 1, PEABODY HALL

1. 9:00 An Alternate Form of the Shipley-Hartford Abstraction Scale.
Reuben S. Horlick; *Walter Reed Army Hospital, Washington, D. C.*
2. 9:20 Abstract and Concrete Thinking in Schizophrenia: A Vocabulary Study.
A. W. Jeffreys; Jr.; *Richmond Professional Institute.*
3. 9:40 An Investigation of Revised Beta Scores (Lindner-Gurvitz Scale) Among Negro Adolescents.
Walter A. Woods, Jack H. Boger, and Georgiana Holman; *Richmond Professional Institute.*
4. 10:00 House-Tree-Person Research on Children.
Richmond Professional Institute
 - a. Theory and Method in H-T-P Research.
Vytautas J. Bieliauskas.
 - b. Developmental Patterns in House Drawings.
Walter A. Woods and Lawrence Repucci.
 - c. Developmental Patterns in Tree Drawings.
Frank X. Duffy.
 - d. Developmental Patterns in Person Drawings.
Vytautas J. Bieliauskas and L. W. Pennington.
 - e. Visual Perception and Developmental Patterns in H-T-P.
Walter A. Woods.
5. 10:40 The Influence of Emotional Neglect on the Test Scores of Infants.
Catherine T. Giblette; *Memorial Guidance Clinic, Richmond.*
6. 11:00 Diffusion Theory and Its Application to Social Research.
Henry Winthrop; *Richmond Professional Institute.*

7. 11:20 Preliminary Evaluation of Rorschach Characteristics of Some Alcoholic Patients.
John Mendenhall; *Lynchburg State Colony.*
 8. 11:40 Identification and Guidance of the Gifted at Early Ages in the Public Schools — Discussion of the Problem and Outline of a Plan.
Antonia Bell Morgan; *Aptitude Associates, Merrifield.*
- 12:00 Noon-1:00 P.M. — Junior-Senior Scientist Hour — Auditorium, Cabell Hall.

EXPERIMENTAL SECTION — 9:00 A.M.—ROOM 15, PEABODY HALL

1. 9:00 Visual Differentiation after Non-reinforced Training in Differentiated Alleyways.
Melvin Freitag; *University of Virginia.*
 2. 9:20 An Experimental Evaluation of the General Drive Concept.
James G. Holland; *University of Virginia.*
 3. 9:40 Conflict-produced Changes in the Behavior Patterns of Rats.
William A. Lee; *University of Virginia.*
 4. 10:00 Cutaneous Communication Systems Utilizing Mechanical Vibration.
Paul Spector; *University of Virginia.*
 5. 10:20 Visual Contribution to Speech Intelligibility in Noise.
William H. Sumby; *University of Virginia.*
 6. 10:40 Duration of Success Background and the Effect of Failure upon Performance.
James A. Bayton; *Howard University.*
 7. 11:00 The Effect of Variable Amount of Reinforcement upon the Rate of an Operant Response.
Kenneth Hageman; *College of William and Mary.*
 8. 11:20 The Effect of Knowledge of Results (Reinforcement) on the Accuracy of a Pure Guessing Response.
Burton R. Wolin and Althea M. Iliff; *College of William and Mary.*
 9. 11:40 The Effect of Differing Quality of Reinforcement upon the Level of Performance.
William Wagman; *College of William and Mary.*
- 12:00 Noon-1:00 P.M. — Junior-Senior Scientist Hour — Auditorium, Cabell Hall.

FRIDAY, MAY 7, 1954 — 2:00 P.M. — ROOM 106, PEABODY HALL

- 2:00 Business Meeting of Psychology Section.

- 3:00 Symposium: What Kind of Research Studies Do Clinical Psychologists Need.
Chairman William M. Hinton; *Washington and Lee University.*

Section of Science Teachers

CAROLINE GAMBRILL, *Chairman*
C. L. THOMASSON, *Chairman-Elect*
MARTHA W. DUKE, *Secretary*
L. W. JARMAN, *Section Editor (1954)*

FRIDAY, MAY 7, 1954 — 9:30 A.M. — ROOM 122, COBB CHEMICAL LABORATORY

- 9:30- 9:40 Appointment of Committees.
1. 9:40-10:00 The Science Teacher's Responsibility in Civil Defense.
Thomas E. Gilmer, *Hampden-Sydney.*

FRIDAY, MAY 7, 1954 — 10:00 A.M. — ROOM 200, COBB CHEMICAL LABORATORY

2. 10:00-10:30 Atomic Energy.
Edward C. Stevenson, *University of Virginia.*
3. 10:30-11:00 What's New in Crystals.
Nicolas Cabrera, *University of Virginia.*
4. 11:00-11:30 What's New in Nuclear Physics.
Frank L. Hereford, *University of Virginia.*
5. 11:30-11:50 Report of Nominating Committee.
Election of Officers.
11:50 Adjournment.

12:00 Noon-1:00 P.M. — Junior-Senior Scientist Hour — Auditorium, Cabell Hall.

Section of Statistics

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FRIDAY, MAY 7, 1954 — 9:00 A.M. — ROOM 243, CABELL HALL

- 9:00 Introductory Remarks of the Chairman.
1. 9:10 Three Decision Tests of Difference Between Two Means.
D. B. Duncan; *Virginia Polytechnic Institute*.
 2. 9:35 On a New Method of Analyzing Extreme-High Value Data.
Julius Lieblein; *National Bureau of Standards*.
 3. 10:10 Some Duplex Methods of Using Desk Calculators in Statistics.
M. C. K. Tweedie; *Virginia Polytechnic Institute*.
 4. 10:35 On a Problem in Fitting a Straight Line.
W. S. Connor; *National Bureau of Standards*.
 5. 11:10 Some Topics in Variance Component Analysis.
W. A. Thompson, Jr.; *Virginia Polytechnic Institute*.
 6. 11:35 Business Meeting.
- 12:00 Noon-1:00 P.M. — Junior-Senior Scientist Hour — Auditorium, Cabell Hall.

FRIDAY, MAY 7, 1954 — 2:00 P.M.

7. 2:00 Statistical Analysis of Insonation Effects on *Escherichia Coli*.
Miss Patricia Ripley, M. C. K. Tweedie, and D. Thompson; *Virginia Polytechnic Institute*.
8. 2:25 A Minimization Program.
J. B. Jordan; *U. S. Air Force*.
9. 3:00 Optimum Transportation.
M. DiCarlo-Cottone; *U. S. Air Force*.
10. 3:35 Automatic Programming.
Miss N. Coplan; *U. S. Air Force*.
11. 4:10 Some Aspects of Abnormality of the Distribution of t.
J. C. Layman and R. A. Bradley; *Virginia Polytechnic Institute*.
12. 4:35 Analysis of Pastural Data in Three by Three Latin Squares with Rows and Single Observations Missing.
N. R. Thompson and C. Y. Kramer; *Virginia Polytechnic Institute*.

SATURDAY, MAY 8, 1954 — 9:00 A.M.

13. 9:00 Some Aspects of Statistics in Canada.
G. L. Edgett; *Virginia Polytechnic Institute and Queen's University*.
14. 9:25 A Two by Two Factorial with Paired Comparisons.
R. M. Abelson and R. A. Bradley; *Virginia Polytechnic Institute*.

15. 9:50 Testing One Sample Hypothesis Against Another.
Lionel Weiss; *University of Virginia.*
16. 10:25 Current Research in Livestock Estimating.
H. F. Huddleston; *U. S. D. A.*
17. 11:00 Some Problems of Optimum Sampling.
P. N. Somerville; *Virginia Polytechnic Institute.*

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C O N T E N T S

	Pages
The Role of Statistics in Scientific Research — M. G. KENDALL	119
Sex Factors and Selection in Experimental Populations, With a Note on Selection and the Sex Ratio — MAX LEVITAN	131
Energy Dissipation in Vibrating Solids — J. A. SAUER	144
The Distribution of Poisonous Snakes in Virginia — JOHN THORTON WOOD	152
A New Branchiobdellid of the Genus <i>Cambarincola</i> (Oligochaeta, Branchiobdellidae) from Virginia — PERRY C. HOLT	168
Changes in the Physiography of Oyster Bars in the James River, Virginia — NELSON MARSHALL	173
News and Notes	182

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No. 3

The Role Of Statistics In Scientific Research

M. G. KENDALL

University of London

There is a good deal of misunderstanding about the scope of statistics even, perhaps, among the scientists who are accustomed to using statistical methods. I would like to give a broad account of the basic nature of the subject and to explain also why statisticians are such peculiar beings and manage to find some kind of interest even in what many think to be the most uninteresting of all subjects.

THE NATURE OF THE STATISTICAL METHOD

I begin by dismissing certain misconceptions about statisticians. There is a story that at the outbreak of war the Army, wanting some advice in the engagement of its professional personnel, sent a letter to one of the universities, saying: "The Army requires the following expert personnel: two cooks, three butchers, two statisticians." That is the level on which many people place the occupation of a statistician, as a numerical hack who adds up a column of figures.

Now, it is true that the statistician is concerned with numerical data, and it is easy to draw the inference that his primary interest lies in the actual handling of such data; but that is to misunderstand the essentials of the statistical approach. One might as well say, for example, that an artist is primarily interested in the properties of paint or that the astronomer is primarily interested in measuring the right ascension of stars. The statistician uses numerical material but he is always trying to find some truth about the physical world that lies behind them. Numbers are the raw material of his craft, and have a certain fascination of their own, but they are not in themselves the ultimate object of his research.

The statistician, in fact, is concerned with the properties of aggregates, and statistics, as far as definition is possible, may be defined briefly as that branch of scientific method which deals with assemblies, collections, or aggregates. In one sense, practically the whole of science, in the sense of organized knowledge about the external world, is concerned with collections of one kind or another, even if only with collections of observations of a particular situation. Statistics is man's attempt — the most successful attempt, I think, up to date — to cope with the complexity of things and to reduce them to law and order. It used to be said that mathematics was the matrix of the sciences. Nowadays it is statistics which is the matrix of the scientific method, moulding in some way practically the whole field of scientific endeavor. That may seem rather a large claim

to make, and I make it in all humility; but that is, in fact, the thesis that is to be developed. I shall begin by showing in some detail how particular statistical ideas or particular branches of statistical methods are applicable in an enormous number of different sciences.

Some groups of problems: (a) *Gambler's ruin*.—I shall consider three groups; the first of them arises in a very old form as the problem of the ultimate ruin of the gambler. In its simplest form, we consider two players, A and B, who are playing a fair game such as one might get if he were tossing an unbiased coin and betting on whether it fell heads or tails. This situation leads to all sorts of topics in probability, one of the most important being the proposition to the effect that if A has a much larger stake than B, it is very nearly certain that A will ruin B; and that one can see without any detailed mathematics, because there will occur long and short runs of bad luck, and the man with the smaller stake is the man who is least able to withstand them. Consequently, if he is unable to borrow, there will almost surely come a time when he is ruined. In particular, the inference which is usually drawn from this is that if one man is gambling against a set of people with practically infinite resources, the result is that he is morally certain to be ruined. This is the famous theorem of the ultimate ruin of the gambler; for he plays against the rest of the world and hence against practically unlimited resources.

I am not concerned, however, nor is the statistician concerned, with the moral implications of such results. You might suppose that apart from such implications, theorems of this type have no very direct application outside the field of gambling itself; but it is there that the statistical viewpoint begins to assert itself, for in a sense, a great many of the decisions that we make, in science as well as in ordinary life, are in the nature of gambling. For example, in sampling (and a very great deal of scientific thought is based on samples of some kind or another), we are rarely able to make a categorical assertion about the population; we take a gamble on the truth of certain inferences drawn from the sample. We express our conclusions in terms of probability. We are never sure; we make as sure as we can, that is to say, we try to cut down the risk to a minimum; but we can rarely eliminate it altogether.

This basic idea has led to a very large number of applications. For example, during the war, when sampling was carried out very extensively in the testing of certain components which were being manufactured on a very large scale, there occurred the problem of economy in the sample size. The extreme case, perhaps, is the one in which we have what is called destructive sampling. If we are manufacturing bullets or shells, there is only one really satisfactory way of finding out whether the bullet is a good one, and that is by firing it. But we cannot test all our bullets in such a fashion and still have a supply to use on the enemy, so we have to take samples; and in order to get the testing process performed as quickly as possible, we try to economize in the amount of sampling that we do.

Consider a two-dimensional network of the kind shown in Figure 1. We choose our objects for test one by one, and to any sequence of objects

we associate a path on the network in the following simple way: beginning at the origin we move one step to the right if the first object is a 'success', *i.e.* passes our test, and one step in the vertical direction if it is a failure, *i.e.* does not pass the test; similarly for the second object, beginning at the end of the path corresponding to the first object; and so on. A random set of objects will then correspond to a random walk on this network. Now if we decide, on prior grounds, that we are prepared to tolerate a fraction x per cent failures in the total population from which our sample is drawn, and that we wish to make a correct judgment in y per cent of the cases whether this fraction is exceeded or not, we can set up, by calculations based on the theory of probability, certain barriers such as A and B on the network and proceed as follows: we trace the path corresponding to the observed sample until it strikes one of the barriers. If it strikes A we accept the population as having not more than x per cent failures; if it strikes B we reject the population. This is a simple case of what is known as sequential sampling.

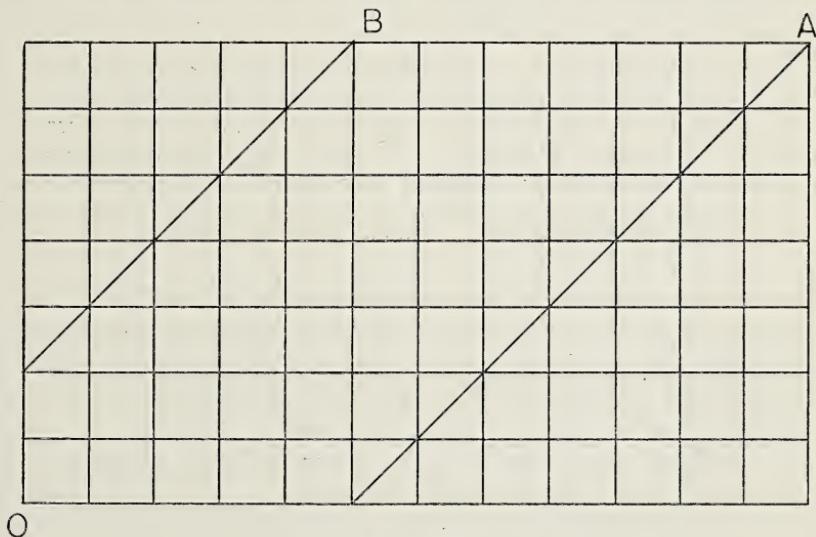


Figure 1.

Now this is very much the situation which we study in the problem of the ruin of the gambler. In the simple version we are considering bound A corresponds to a man with a certain amount of stake represented by a . B corresponds to a second player with stake b . If we reach bound A the first player is ruined (we accept the population), if we reach B the second player is ruined (we reject the population). Whether we accept or reject in a number of trials thus corresponds to the relative frequencies with which gamblers like A and B will be ruined in games of this type. By using propositions derived from the theory of such games we managed, by the development of sequential sampling, to cut down the

average sampling required on destructive sampling by about fifty per cent.

To take another illustration — and I am jumping from field to field as sharply as I can — I refer to a genetical problem which in its simplest form can be stated as the proposition that ultimately everybody's surname will be Smith. Let us put the case in its simplest form: suppose that every married couple has only two children, so that the population reproduces itself, and that all children intermarry. Let us also suppose that the probability of any child being male is $\frac{1}{2}$. Then a male child perpetuates the surname but a female child loses it. Thus the chance of perpetuation is $\frac{1}{2}$ and over a number of generations the chance of survival is very much what it would be if that surname were gambling against all the others in a fair game with an even chance of winning at any one throw. Now by historical accident the Smiths have got themselves into an advantageous position, that is to say, they have a large stake, and it is therefore virtually certain, in the sense of the theory of probability, that the other surnames cannot compete. There will be a run of bad luck which will extinguish them, and so in the course of time, everybody's surname will be Smith, in the same way that in gambling all the money ultimately is concentrated in one hand. You may not think perhaps that this particular effect is very important, but if you replace surnames by certain genetic characteristics the question of survival obviously can become of extreme importance. The actual situation governing the transmission of biological characteristics is, of course, much more complex, but fundamentally, under random mating, is the same as in the problem of the gambler.

I take a further generalization of the gambling situation. The case we have already considered may be regarded as a random walk on a network under two conditions: one is that one has a choice of only two directions (horizontal or vertical) and the other is that one always moves outwards from the origin and never return towards it. If we remove those restrictions, we get a more general random walk problem.

Let us suppose that a mosquito starting from a malarial site at 0 in Figure 2 flies the same distance each day — I am over-simplifying the situation, of course — but chooses its direction at random. The mosquito might perform the kind of path shown in the diagram and at the end of n days it will be a certain distance from its origin. Again we have, in a sense, a gambling problem. We are interested in the question how far that mosquito has proceeded from his center after a certain period of time; but this is not a determinate distance; it depends on the chances inherent in the random choice of directions. It is a problem in pestology where we want to know, for example, how rapidly we shall get a spread from the infected place. Clearly, under random conditions there will be very few cases in which the mosquitoes will fly in the same direction on successive days, so there will be a rather thin scattering on the boundary, but there will be quite a lot of them in which the mosquitoes return more or less to the neighborhood of the starting point, so that we get a sort of heaping up of the density around the original site of infection, and

the plague will spread outward; and it is in the rate of spread of similar vector borne diseases that the immunologist is interested.

To go from mosquitoes to the theory of sound; there is a similar problem in which we have an incoming train of sound waves, and we are concerned to know whether they are really ‘noise’ (in the sense of being composed of elements with random phase) or whether there are systematic harmonic components present. We can represent the situation as a kind of mosquito flight, in which the amplitude of any component corresponds to the length of the flight and the phase to the direction. If the signal we receive is noise, these phase angles are more or less at random. Thus we can examine the presence of systematic components by using, in a different context, the theory of the random walk.

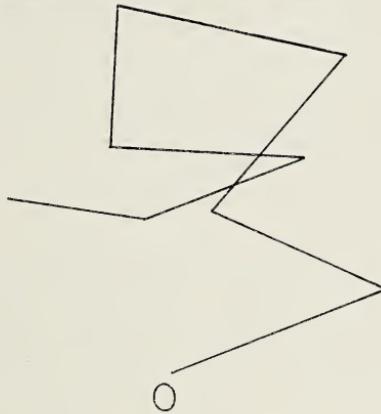


Figure 2.

Finally, to go from pure physics to economics, we require the same kind of theory in the analysis of the trade cycle. Suppose we have a time series which is thought to incorporate certain systematic oscillatory properties. We analyze the series into harmonic constituents, and our interest is in testing whether the effects which emerge are significant. This again brings us to the problem of ascertaining whether a “random walk” of harmonic components presents evidence of systematization or not.

Thus, starting out from what appears to be a highly formalized problem in gambling, we find applications to industrial standardization, genetics, immunology, physics, and economics. A large number of different physical situations present to the statistician, on analysis, a unified class of problems in random variation. Thus, the way in which the statistician branches out into other fields and has fingers in all sorts of pies becomes obvious.

Some groups of problems: (b) *the theory of queues.* —I take another group of examples of this kind. We have, in England, what we call a queue (the American equivalent, I think, is a line-up) in which a number of individuals wait in a line for some sort of service; for example, human beings waiting for a bus, or automobiles waiting for attention at a service station. We set up a conceptual situation in which we have a number

of individuals lined up for some kind of attention. We suppose that their input has a certain pattern, the queue is subject to certain rules, and the service-time has a certain output or pattern. We are interested in the behavior of the queue under certain hypotheses concerning these patterns, e.g., what is the most efficient ratio of service-time to the average input time, whether the queue is going to get out of hand in the sense that it grows too long, or whether there is a waste of time in the sense that so many resources are diverted to the output service that some of them are idle for substantial periods of time, and so on. Now that again may appear to you a highly abstract situation with few fields of application. In fact, it conceptualizes a class of problems with very wide and important applications. Historically, I believe, it first arose for study in problems connected with the control of telephone traffic and the design of a telephone switchboard. Consider, for example, a number of incoming calls on a switchboard; in general, there will be a queue of them on the lines; there will be a service mechanism represented either by an actual human operator or by a mechanical device. Given the number of subscribers and the pattern of incoming calls we may require to know how big our switchboard must be, how many people we want to employ on it, what is the most economic setup, etc.

What applies to telephone traffic is obviously extensible at once to other sorts of traffic. Consider, for example, the design of road traffic signals. Here, instead of having a single queue, we have a double queue of traffic moving in opposite directions, or in more complicated places such as crossroads and circuses we may have more. A typical problem now is to know how often street lights must change in relation to the known intensities of traffic, in order to achieve a minimum waiting time on the average, but also with certain further conditions; for example, we must also try to avoid such a long queue as to block previously occurring cross-streams of traffic. A similar type of problem arises in the design of aerodromes, where we have a limited air strip, and a large number of aircraft taking off or coming in. This is the kind of problem that was a very serious one during the war when we had a large number of bombers coming back from a raid, some of them badly shot up and therefore requiring special attention, and all of them queueing up in the air waiting for the service of landing. Again, we have a situation involving an influx of random arrival and an output of, not necessarily random but not always systematic, discharge in the form of the servicing mechanism.

A situation of a somewhat different kind occurs in industrial engineering. Suppose we have a number of looms which are spinning cotton. Every now and then a thread breaks and the corresponding machine automatically stops. We therefore have certain service operators present to mend these threads when they break. If we have only one operator looking after a number of machines, there may be a queue of machines waiting for service, and we may lose a great deal of machine time. On the other hand, if we have one operator to each machine, he spends ninety-nine percent of his time in reading a newspaper. Between these two extremes, there is an optimum situation, in which we get the best of both

worlds by economizing in the machine-time and balance the loss of time against the cost of the labor service. Here again, we have a rather more complicated queueing system in which we have, in general, a multiple input and possibly also a multiple output. You can see, without my elaborating the point, that the same idea may run all the way through an enormous number of applications wherever we have servicing mechanisms and a number of individuals coming in to make use of them.

Some groups of problems: (c) the theory of preferences.—I would like to take one further group of cases by way of exemplification, in a rather different field, namely, in the theory of preference. Here we are interested purely in the situation which arises when a certain number of people consider a certain number of objects and express preferences between them, as for instances when a number of consumers express preference between varieties of ice cream. The applications of this situation are again numerous and varied. For example, the whole system of academic examinations is effectively based on preference; the examiner has by some means or other to arrange his subjects in a rank order, and a rank order is a particular case of a set of preferences. An industrial example arises from spraying paint on a motor car where we have a number of different kinds of lacquer being applied, a number of different individuals doing it, a number of different methods of doing it, and finally, we have no objective means of measuring the excellence of the lacquer on a car. All we can do is to get a number of judges to express preferences, and so, out of the resulting scheme of preferences expressed by judges who themselves may be fallible, we have to try to allocate sources of differences between the types of paints, the types of methods, the types of operators, and the types of judges.

We use a similar technique based on preferences in studies of social mobility — I choose this example from the field of sociology because it is one of the most recent ones; for example, suppose we are interested in finding out whether people can move from one social class to another more easily now than they could fifty years ago, which is quite an important social problem from some points of view. We go to a number of individuals and ask them what their occupation is and what their father's occupation was; and we also ask their fathers, if we can locate them — or the individual if we cannot — what was the grandfather's occupation. We then have a sort of situation in which, if you classify these occupations into certain grades, any man who is now, say, in grade 3 may come from the higher grades 1 or 2, or from grade 3, or from lower grade 4, etc. We now have for each person not a preference but a comparison, which is the same thing for this purpose—a comparison between the grade his father was in and the grade in which he is himself. Out of the general complex of comparisons we have to try to build up some kind of measure of the extent to which people as a whole transfer themselves from one grade to another over a period of time, and hence set up some kind of measure of social mobility. Similar problems arise in linguistics, and to some extent, in anthropology, but I shall not elaborate on them. I will, however, mention one point in this preference scheme which is of con-

siderable importance in economics. The older theories of economics tried to set up a theory of price or demand based on what was called "utility" — there was supposed to be in each object some rather mysterious concept called utility, the total of which was maximized by a consumer. Nowadays, we realize that it is not altogether satisfactory to explain something you do know by something you do not — so we try to overcome the difficulty by setting up systems of preference; for example, we suppose that if the consumer is offered varying quantities of two commodities, he will either prefer one to the other, or he will have no preference between them, in which case we can map, as it were, a series of what we call "indifference curves" between his various expenditures at different consumption levels. On the basis of these indifference curves we can set up a theory of demand. The interesting thing about this basis, a point which I think economists overlook, is that if we try to aggregate a set of preferences which are consistent we may arrive at a set which is inconsistent. It is virtually impossible for an individual to prefer A to B, B to C, and still prefer C to A; he doesn't as a rule behave that way. But it is perfectly possible to get a thousand consumers, each of them consistent in his preferences in this sense, who, *on the average*, prefer A to B and B to C, but still, *on the average*, prefer C to A. Thus, certain of the consistency conditions we meet in the basis of demand theory may well not be obeyed; or, if they are obeyed, it is up to the economist to prove it experimentally.

THE ESSENTIALS OF THE STATISTICAL METHOD

Up to this point I have deliberately chosen my examples from as many different branches of science as possible (and perhaps I ought to say that I do not pretend to be an authority on any one of them). It may perhaps have occurred to the reader to wonder what some of these things really have to do with statistics. In the case of the queueing problem, for example, why is this a statistical and not a mathematical problem? If in any system of queueing the service time were constant, and people were arriving and leaving regularly, it is obvious that the problem would be a purely mathematical one. The necessity for discussing the problem statistically arises from the fact that there is some element of chance in the situation. There is an element of randomness in the time of arrival, there is an element of randomness, perhaps, in the time of service for different people, and the differences which one can get between the statistical approach and the purely mathematical approach are sometimes enormous. For example, in the queueing problem, suppose that individuals arrive on the queue once every minute and leave it after service once every minute, it is obvious that the queue will remain constant in size and is, so to speak, under control. But if the arrivals are randomly distributed in time but are at the rate of one a minute, and if the service times are also random but average one a minute, the system is out of control; there will inevitably come a time when the queue is longer than any number you like to think of beforehand. This is a very simple

illustration of the abrupt differences we may get in proceeding from the mathematical case to the statistical case....It is with events which incorporate some elements of chance or randomness in their occurrence that statistics is concerned. Such a chance element can occur in many ways, by the ordinary throwing of dice, as in the gambling problem; in the random walk problem by casual disturbances or arbitrary choices of direction; in the traffic problem by randomness in time; in preference systems by errors on the part of observers, etc. Everywhere we are dealing with events which have essentially a chance element in them, and in fact, we have a word for such happenings. Nowadays, we call them stochastic, which is a rather precious way, perhaps, of saying "random" or "casual."

When chance is at work in a system, we cannot say anything definite about its behaviour on a single occasion or at a single trial. It is at this stage that we return to the previously mentioned aggregates, because that is where the interest of the statistician lies. Having an experience in dealing with aggregates, and sacrificing the possibility of being certain about behaviour on an individual occasion, he tries to formulate laws of behaviour of collections of occasions. He knows that he cannot predict a single event, but he can and he does successfully predict what will happen in the long run, or in the aggregate, or on the average. Every bridge player, of course, does this, and indeed every individual does a good deal of it for himself in making the decisions of ordinary life. All that the statistician does is to study the necessary procedures intensively, classify them and reduce them to rules. It is, in fact, one of the most peculiar features of modern science that chance, which seems to be conceptually the antithesis of law, is itself reducible to law and can be brought under control and the bringing under control is the main task of the statistician. It is his job to explore the extent and nature of chance variation, and wherever possible, to reduce it; or if he cannot reduce it, to measure it, to gauge its extent on the average, and hence, to bring it under control.

This statement, if it is correct, explains why the statistician is led to take part in the development of pure mathematics on the one hand and the development of scientific inference on the other. In mathematics he has, in a sense, invented a new complexity in mathematics. In fact, ordinary mathematics deals with a variable, and the mathematical variable is distinguished by the characteristic that although it can have certain values, one never thinks of it as having certain values more frequently than other values. In statistics, we deal with a random variable which also may take values in a given range, but is to be conceived of as taking certain values more frequently than others, a fact which we express by saying that it has a distribution function, or a probability distribution, or something of that kind. So that, instead of setting up, as it were, a calculus of mathematical variables, we set up a calculus of distribution functions, and that adds a great deal to the complexity of the mathematics which we have to use in statistical theory. The main difficulties of modern mathematics arise out of limiting processes and the justification of inverting certain limiting processes, such as summation of an infinite series and integration.

In statistics, very briefly, we do not encounter any new type of mathematics, but we do, as it were, import another degree of infinity into the problems by having to speak now of distribution functions instead of mathematical variables. It is true, however, that over the course of the last thirty years, practically every branch of mathematics has been overhauled to meet some statistical requirement. Branches of mathematics, like the theory of symmetric functions, which have been put away in the mathematical lumber room for many years, have all been taken down, dusted, used, and in many cases, elaborated. I think it is fair to say that the requirements of the statistician provide one of the most powerful stimuli in mathematical research, but I also express a personal opinion that statistics is not a branch of mathematics. This is a contentious point, but what I mean by that is that there are in statistics ideas which find no place in mathematics, although they are amenable to mathematical treatment. In one sense, the idea of chance is antithetical to mathematical demonstration, which relies so much on the certainty of its deductions. Statistics relies on certainty of categories and the uncertainty of its individuals, and although it tries to express its ideas within the framework of existing mathematics, conceptually it is, I maintain, not a branch of mathematics. One might, perhaps, say that it is a branch of applied mathematics, just as one can say that the theories of electricity, magnetism, optics and heat, are branches of applied mathematics; but when we really come to apply them, we do not often think of them as such, and when we really come to apply statistics, I don't often think of them as such, either.

I mentioned also, at the other extreme of the scale, that the statistician is interested not only in pure mathematics, but also in uncertain inference, and here he has a very definite role to play because, as I explained, he is thinking all the time in terms of random events, and hence, in terms of probability. He sacrifices all hope of being able to make assertions about the future in terms of deterministic rules, but he does not sacrifice the possibility of being able to make statements in probability, and in fact, he does exactly that. Nearly every conclusion we draw in statistics is stated in terms of a certain amount of confidence, but not in terms of certainty. I don't want to appear to take too much credit to the statistician for inventing this idea because certain of the physical scientists arrived at the basic idea for themselves, even perhaps before the statisticians did so. The classical case is the kinetic theory of gases, where the physicist gave up all attempts to try to formulate the laws of motion of each of a set of molecules, but formulated the laws of aggregates of molecules. The same thing happened in the theory of heat; and of course in certain modern developments, like quantum mechanics, where you replace an electron by a wave of probability, a very high degree of statisticalization has been reached. The idea, however, is essentially the same; one cannot say what is happening on an individual occasion; one can say what is happening on a collection of occasions, and hence, whether one likes it or not, one is a statistician. It was Eddington, I think, who once said that the hero of the nineteenth century would have been the man who could explain gravitation by means of cogwheels. The hero of

the early twentieth century would have been the man who could explain physical laws in terms of mathematics. We have abandoned that approach; the hero of the latter part of the twentieth century is going to be the man who can explain physical behaviour, using that in its general sense, in terms of the laws of probability.

The reader can now, I hope, appreciate how the statistician looks at things; why he takes an interest in so many different fields; why statistics is very far from being a dull subject; why the statistician feels an immense pride in the scope of his weapons, but at the same time an immense humility at their lack of precision.

EXPERIMENTATION

I should like, in conclusion, to emphasize certain aspects of the theory of experimental design. In the old days, the statistician — who was usually an economic statistician — had to take what data he could get and be thankful. It was turned out for him by some other machine; he very rarely was able to get it himself. Nowadays, we are beginning to alter that. Whereas, formerly, a statistician, like a physician, was usually called in when the patient was nearly dead, nowadays, so far as possible, we encourage everybody to call him in before anything is really going wrong with the patient at all. In the old days, the statistician made a gallant effort to deal with the data, and that often got him into disrepute. The statistician had to surround his conclusions with so many safeguards and reservations that he presented the picture which I think is still in many people's minds, the picture of a man who constitutionally cannot make up his mind about anything and under pressure can produce any conclusion you like from the data. Now, you must not shoot the statistician; he was doing his best, having had both hands tied behind his back by being denied the possibility of saying anything about the way in which the data were collected. The point which we endeavour to emphasize so much nowadays is the importance of utilizing the statistician as a consultant at the beginning; and if one does that and has a very clear idea of what one wants him to do, he can in fact set up complicated and delicate systems of experimental design which save an enormous amount of labor, both on his part and on the part of the scientist who carries out the experiment.

My final point is that, great as is the field of application of the theory of experimental design, we are really in one sense only at the beginning of developing what one might call a scientific theory of experimentation. It is a rather paradoxical thing, when one thinks about it, that although we have now three hundred years of extensive experimentation, there is very little systematic, logical, and generally accepted theory of the subject. The statistician has a considerable part to play in the development of such a theory, by studying the nature and extent of experimental error, the extraction of the maximum amount of information, and the minimization of effort required to attain given precision.

SUMMARY

To summarize very briefly: I have tried to show that the statistician, although he is necessarily dealing with numerical data, is not, so to speak, primarily interested in them, except insofar as they are a weapon for handling aggregates. It is in the aggregates that he is interested; he sets up a calculus of aggregates; he expresses his thoughts in terms of aggregates, through the medium of probability; in particular he has a contribution to make towards the study and control of error; and since error arises wherever measurement is made there is in practically every scientific field a place for the statistician.

Sex Factors and Selection in Experimental Populations, With a Note on Selection and the Sex Ratio

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Modern biologists generally agree that the generalization most responsible for the tremendous advances in biology in the past three-quarters of a century is the theory of evolution. In retrospect the influence of Darwin's work seems truly amazing when it is realized that two of its central theses rested in his time on exceedingly weak grounds. Darwin and his colleagues were very vague on the question of how new hereditary variation arose. They were even in total error in their concepts of how this variation could spread once it appeared, since they believed essentially that when two variants were crossed the result was a blending of the inheritance contributed by each. Admittedly, the other fundamental proposition of evolution, natural selection, was based even in Darwin's time on a considerable body of indirect evidence. This consisted mainly of inference from plant and animal morphology, distribution, and natural history. Since Darwin these lines of evidence have been further strengthened and a beginning made to correlate them with the principles of genetics (see especially the monographs of Dobzhansky, 1941, Mayr, 1942, and Simpson, 1949, and the mathematical studies of Fisher, 1930, and Wright, 1931). Experimental demonstration of natural selection, however, has been scant. Similarly, there has been little study of the problem's quantitative aspects, such as measurements of the intensity of the selective process. Considerable progress in eliminating this deficiency has recently been made by Dobzhansky and his colleagues in studying chromosomal variants of *Drosophila* of the *obscura* group (subgenus *Sophophora*) in population cages. The work has been reviewed by Dobzhansky (1947 and 1949). It has demonstrated that natural selection could be studied in the laboratory, often duplicating observations in the field, and that the intensity of the process was often much greater than had theretofore been imagined. Using similar methods, the writer found that certain chromosomal variants of the Eastern woods species *Drosophila robusta* Sturtevant (subgenus *Drosophila*) also showed large differences in selective value (Leviton, 1951a). In one of these experiments a further study was made to determine at which period of the life cycle selection occurred. The present paper reports the results of this study together with a re-examination of the experiment in the light of the new data. Data are also presented concerning the stage of the life cycle responsible for the unusual preponderance of females noted in the populations. As these data are presented they will be used to describe many of the theoretical bases for this field of experimental biology and to show how the conclusions drawn often carry implications reaching into many aspects of genetics and evolution.

MATERIAL AND METHODS

The equipment and procedure used in the population cage study were essentially those described by Wright and Dobzhansky (1946) and modified for *D. robusta* by Levitan (1951a). The population mainly to be discussed here, No. 4, involves competition between carriers of two gene arrangements of the left arm of the second chromosome, 2L and 2L-1, for a common food supply. These arrangements, which differ by a one-step inversion of approximately the middle third of the arm, are described by Carson and Stalker (1947). The experiment was begun September 23, 1948, with 878 flies, half of each sex, representing 12 strains of each arrangement (each strain descended from a single fly collected in the New York City area by the author). The initial chromosomal constitution was estimated as 81.3% 2L and 18.7% 2L-1. During the first generation the cage was in a 25° C. room with variable humidity, but thereafter it was kept in an incubator maintained at 25° C. and 89-92% humidity at Columbia University, New York. On September 8, 1949, during the ninth generation, the cage and its contents were moved to Virginia Polytechnic Institute, Blacksburg, and maintained under similar conditions there from September 17 to the present.

Sampling of generation 16 was delayed about two weeks, so that most or all of the eggs and larvae present were the offspring of that generation. The adults were then removed, counted, placed in a new cage, and an egg sample taken from them. The food cups from the original cage were attached to stoppered glass cylinders of the same diameter with tape. These were kept in the same incubator. Flies hatching in the cylinders were collected at five day intervals, aged five to seven days (males and females separately), and mated individually to flies known to be homozygous for 2L. Salivary glands of eight larvae from each cross were smeared in acetocarmine and their chromosomes examined.

Another cage, No. 16, was intended as a study of arrangements 2L and 2L-3 (also described by Carson and Stalker, 1947). An undetected opening into the cage allowed contamination, during both the parental and F₁ generations, by *Drosophila melanogaster*. This accident proved fortunate in making possible two additional counts of hatching *D. robusta* for comparison with the mature adult populations. Flies hatching from the cups outside the cage were collected as with No. 4, but in this case the newly-hatched *D. robusta* were returned to the cage immediately after being counted.

RESULTS AND ANALYSIS

Table 1 shows the results of sampling the eggs laid by population No. 4 for seventeen generations. The data show rapid, directional changes in arrangement frequencies in this cage until the eighth generation. During this period the frequency of 2L dropped to less than half its initial value, 2L-1 showing a concomitant rise. Thereafter, directional changes appear to be absent, the samples showing only apparently random fluctuations about an equilibrium of approximately 35% 2L and 65% 2L-1.

Wright (1931) discusses four possible causes of changes in frequencies of genetic variables in a population, namely, mutation, selection, migration, and chance factors in the reproductive process (genetic drift). Only selection offers a possible explanation for the changes observed here. Migration was, of course, impossible. The changes were too rapid to have been caused by mutation, and their directional character makes genetic drift extremely unlikely. Wright showed further that the simplest explanation for selective changes which lead to equilibrium is that the heterozygotes are adaptively superior to either homozygote, the point of equilibrium being determined by the relative adaptive values of the homozygotes. In such a case he has demonstrated (in Wright and Dobzhansky, 1946) that the regression coefficients calculated from the regression of frequency changes with time are expressions of the average selective disadvantages of the homozygotes relative to the heterozygotes. Taking the average adaptive value (W) of the heterozygotes to be 1.00, the adaptive values of the homozygous types would also be 1.00 if they had no selective disadvantage relative to the heterozygotes. When the homozygotes are selectively inferior, their W 's are 1.00 minus their respective selection (regression) coefficients. Using Wright's method for calculating the selection coefficients (*loc. cit.*) it is found that for the data as a whole:

GENOTYPE	W	
2L/2L	0.35	$s = 0.65$
2L/2L-1	1.00	$\hat{q}_{2L} = 0.350$
2L-1/2L-1	0.65	$t = 0.35$

The selection coefficients of 2L/2L and 2L-1/2L-1 are called "s" and "t", respectively. The biological meaning is this: if the heterozygotes in the population are taken to leave 1.00 descendants relative to their numbers in each generation, then the 2L / 2L leave, relatively speaking, " $1 - s$ " descendants, and the 2L-1/2L-1 leave " $1 - t$ ". The quantity

" \hat{q} " represents the equilibrium frequency of 2L that would be expected from these selection coefficients; it can be easily shown that, with minor error, this is equal to $\frac{t}{s + t}$. Although the calculated " \hat{q} " appears con-

sistent with the equilibrium actually attained, inclusion of data from eight samples after equilibrium was reached might seem to influence this result. Also, the change in the first generation occurred at different humidity. Re-calculating from only the data F1 through F8, the following is obtained:

GENOTYPE	W	
2L/2L	0.23	$s = .077$
2L/2L-1	1.00	$\hat{q}_{2L} = 0.364$
2L-1/2L-1	0.56	$t = .044$

Although the relative adaptive values are different, the indicated equilibrium value is again similar to the one obtained experimentally. This set of adaptive values fits the data better than the first set. Under neither set would the equilibrium be expected as early as it was attained, apparently because the method of calculation assumes that the adaptive values are constant. It is more likely that the average adaptive value of the heterozygotes increases slightly during the course of the experiment, as in the data of Dobzhansky and Levene (1951).

Hardy (1908) and Weinberg (1908) independently made a substantial contribution to the study of populations of sexually reproducing organisms. They demonstrated that if there was random mating (panmixia) in a large population in which the frequency of a genetic variant was equal in the gametes of both sexes, the frequency of homozygotes for the variant would be the square of the frequency of the variant itself. Heterozygotes of two allelic variants would have a frequency equal to twice the product of the variant frequencies. Thus in a population consisting of only the chromosomal variants 2L and 2L-1, if the frequency of 2L in both sexes is "q", the frequency of 2L-1 "1 - q", then under random mating the population will consist of

$$q^2 \ 2L/2L : 2q(1-q) \ 2L/2L - 1 : (1-q)^2 \ 2L - 1/2L - 1.$$

In the absence of changes either in the relative proportions of the variants or in the mating character of the population, these proportions of the genotypes will remain constant; hence, they are commonly called the Hardy-Weinberg equilibrium frequencies. These theoretical considerations may be used to detect the stage in the life cycle at which natural selection is acting. If it is known that a population of zygotes consists of the Hardy-Weinberg proportions of the genotypes, it may be inferred that it was formed by random combination of gametes. If no changes in these proportions occur between fertilization and adulthood, the Hardy-Weinberg equilibrium should also be found among the adults. In the population cage cups, if such changes do occur, differential survival of the genotypes between egg and adult stages must be responsible. On the other hand, the absence of such changes would not necessarily indicate the absence of selective forces. Factors such as differential fertility, sexual activity, or longevity among the genotypes are not detectable by this method, unless they caused wide disparity between the frequencies of the variants in the gametes of males and females (and even then would not ordinarily be distinguishable from other factors that can disturb the Hardy-Weinberg formula in egg samples).

The zygotic frequencies of the egg samples in Table 1 were analyzed for consistency with the Hardy-Weinberg equilibrium by means of the Chi² test, each sample having one degree of freedom. Fifteen of the seventeen samples do not depart significantly from the expectation under random mating; the deviations in F₃ and F₁₅ are slightly significant (Chi-squares of 4.515 and 3.860, respectively, for each of which P is between .02 and .05). The data as a whole, however, have a chi-square of 27.861 for 17 degrees of freedom, which is slightly significant (P between .04

TABLE 1.—Zygotic and Gametic Frequencies (in per cent) of Egg Samples from Population 4. All samples consisted of 150 individuals (300 chromosomes).

Sample	Zygotic Frequencies			Gametic Frequencies	
	2L 2L	2L 2L-1	2L-1 2L-1	2L	2L-1
P (Estimate)	—	—	—	81.3	18.7
P ₁ (Sample)	57.3	40.0	2.7	77.3	22.7
F ₁	54.7	36.0	9.3	72.7	27.3†
F ₂	26.7	55.3	18.0	54.3	45.7*
F ₃	21.3	58.7	20.0	50.7	49.3
F ₄	16.7	57.3	26.0	45.3	54.7
F ₅	18.0	52.7	29.3	44.3	55.7
F ₆	16.0	52.7	31.3	42.3	57.7
F ₇	15.3	40.7	44.0	35.7	64.3
F ₈	12.0	42.7	45.3	33.3	66.7
F ₉	—	—	—	—	—
F ₁₀	16.7	51.3	32.0	42.3	57.7**
F ₁₁	7.3	48.7	44.0	31.7	68.3
F ₁₂	6.7	44.7	48.7	29.0	71.0
F ₁₃	13.3	50.7	36.0	38.7	61.3
F ₁₄	10.7	46.7	42.7	34.0	66.0
F ₁₅	12.7	56.0	31.3	40.7	59.3
F ₁₆	10.0	53.0	36.7	36.7	63.3
F ₁₇	10.7	50.0	39.3	35.7	64.3

* First sample in the high humidity incubator

** First sample in Virginia

† Initial sample for the high humidity experiment

and .05). Furthermore, under random mating the frequency of heterozygotes is never expected to exceed 50%, yet this figure is exceeded in more than half of the samples (9 out of 17). In five other samples the frequency of heterozygotes is in excess of expectation, in only three is it below the expectation. If chance alone were responsible, there should be an excess of homozygotes as often as of heterozygotes. The deviation from this expectation for 17 samples is 2.7 times its standard error, giving a P value of about .01. Apparently the egg samples deviate slightly in favor of the heterozygotes. This may be due to slight departures from panmixia, it may be the result of differential egg mortality, or it may arise from differing frequencies of the arrangements in the gametes of males and females. If the last-named factor were responsible an excess of

heterozygotes would be expected among the zygotes without reflecting necessarily any adaptive superiority of this genotype. The average excess of heterozygotes in the egg samples is 3.45 ± 0.83 per hundred individuals, each homozygote being deficient by 1.73 ± 0.48 per cent.

TABLE 2.—Frequencies and Relative Survival Values of the Genotypes in F16 Adult Samples.^a

	a	a _c	e	e _c	W _s	W _{s*}
Males	106					
$\frac{2L}{2L}$	11	10.80	12.92	11.09	.768	.963
$\frac{2L}{2L-1}$	52	52.42	48.18	51.84	1.000	1.000
$\frac{2L-1}{2L-1}$	43	42.78	44.90	43.07	.876	.982
Females	107					
$\frac{2L}{2L}$	5	4.76	11.91	10.06	.307	.392
$\frac{2L}{2L-1}$	61	61.88	47.58	51.27	1.000	1.000
$\frac{2L-1}{2L-1}$	41	40.36	47.51	45.66	.653	.732
Total Adults	213					
$\frac{2L}{2L}$	16	15.56	24.69	21.01	.529	.670
$\frac{2L-1}{2L}$	113	113.91	95.66	103.00	1.000	1.000
$\frac{2L-1}{2L-1}$	84	83.53	92.66	88.98	.757	.849

^a See text for explanation of symbols.

Table 2 shows the results obtained from the analysis of adults of generation 17, cage No. 4, that hatched outside the cage and were mated to $2L/2L$ flies. The classification of homozygotes, made when all examined offspring had identical genotypes, was generally based on eight larvae; one female $2L-1/2L-1$ was based on seven, and one male $2L-1/2L-1$ on six. By this technique some heterozygotes are by chance misclassified as homozygotes. The probability of this error depends not only

on the number of larvae examined but also on the relative probabilities of heterozygotes and each homozygote. Correcting for this error gives the "a_e" values of the table. The Hardy-Weinberg proportions calculated from the arrangement frequencies in each sample, using the a_e values, are listed as "e" in the table. These would be the expected values representing no differential survival between egg and adult stages were the egg samples in concordance with the Hardy formula. Since the egg sample showed a slight excess of heterozygotes and deficiency of homozygotes, the expected values for no differential survival may be similarly corrected, using for this the averages noted at the end of the previous paragraph; the resultant values are called "e_c" in the table. The arrangement frequencies among the adults, 33.2% 2L in the females and 34.9% 2L in the males, are consistent with the equilibrium frequencies suggested by the egg samples (Table 1) and by the adaptive values calculated above. The chi-square test indicates that the differences between the observed and expected zygotic data for the females are probably not attributable to sampling error. This holds true whether the "e" or "e_c" values are used, P being less than .01 or between .01 or .02, respectively. For the male sample the differences are not statistically significant (P may be as low as .30 or as high as .90). For the complete adult sample the differences are of only border-line significance (P about .07), unless the discrepancies from panmixia may be neglected (P less than .01 on the basis of "e").

Relative survival values of the genotypes may be calculated from the data. According to the Hardy formula, the relative proportion of 2L/2L to 2L/2L-1 in an adult sample should be q/2(1-q). Taking the survival value of the heterozygotes to be 1.00, then the observed proportion of 2L/2L : 2L/2L-1 divided by the expected ratio of the two, q/2(1-q), gives the relative survival value of the 2L/2L. Similar considerations apply for 2L-1/2L-1. The homozygote survival value is equal to that of the heterozygotes when the ratio of the two follows the Hardy formula, greater when the observed ratio is larger than the expected ratio, smaller when the expected ratio is larger than the observed ratio. The survival values shown in Table 2 were calculated on the basis both of "e" (W_s) and "e_c" (W_s^*). In all cases the heterozygotes appear to have superior survival value. Considering sampling errors and possible fluctuation in adaptive value not considered in the regression calculations, the survival values of the females are rather similar to the adaptive values of the genotypes calculated from the changes in the population cage. This may well mean that all or most of the female contribution to the overall adaptive values is accounted for by the noted differential survival of the female carriers of these genotypes between egg and adult stages. On the other hand, differential survival, if it occurs at all among the males, cannot account for their contribution to the overall adaptive values, since the resultant adaptive values (given in the table for the total adult sample) are completely different from the ones that apparently were responsible for the changes in the cage. Apparently, natural selection acts in the males at other stages of the life cycle.

The author (Levitana, 1951a) noted that counts of mature populations in the cages invariably gave sex ratios with a high significant preponderance of females. Two of the counts of the older mature adult (P_1 and F_1 of No. 16) and a hitherto unpublished count (F_{16} of cage 4, the parent population of the adults studied above) are given in Table 3. All three counts of the mature flies show the typical excess of females. Comparison of these counts with those of newly hatched flies from the same populations shows clearly that the sexes hatch from the puparia in approximately equal numbers, but the females have a higher survival value during the imaginal stage.

TABLE 3.—Counts of Mature Adult Populations and Their Newly-emerged Offspring in Two Experiments

Population	Cage	Approximate Generation	Total	Females Percent	Males Percent
Initial Adults	16	P_1^*	1000	50.0	50.0
Mature Adults	16	P_1^{**}	361	71.7	28.3
Offspring	16	F_1	1273	57.1	42.9
Mature Adults	16	F_1	393	74.6	25.4
Offspring	16	F_2	844	58.8	41.2
Mature Adults	4	F_{16}	437	86.7	13.3
Offspring***	4	F_{17}	537	53.3	46.7

* Upon introduction into the cage.

** Count began 29 days later; contained a few newly-hatched F_1 .

*** Offspring in cylinders only (see text); offspring in the cage (eggs sampled as F_{17} of Table 1) not counted.

DISCUSSION

It has been demonstrated here that even during a period of equilibrium the carriers of various genotypes do not have equal selective value. This supports the conclusion of the writer (Levitana, 1951a) that in *D. robusta* also the chromosomal polymorphism is adaptive. Furthermore, the finding that the heterozygotes are the most viable type, at least in the females, lends support to the hypothesis that maintenance of the polymorphism depend on the adaptive superiority of the heterozygotes. This allows the polymorphism to exist in spite of the apparent adaptive weakness of some of the genotypes in certain environments and in certain portions of their life cycle (Levitana 1950, 1951a). Paradoxically, the retention of adaptively weak genotypes is of adaptive value to the species, because it gives it increased evolutionary plasticity. The "weaklings" of one environment may be just the ones needed to successfully exploit a new environment.

This study indicates that the evolutionary plasticity of the species may also be increased by adaptive differences between the sexes. In the text

it was shown that only female carriers of the genotypes studied differed in viability. The males were probably also not adaptively equal, but their differences involved some other stage(s) of the life cycle. Likewise, the overall adaptive values were probably different in the two sexes. The writer has also found selectional differences between the sexes in this species in nature (Levitian, 1951a and 1951b). In *D. pseudoobscura*, Wright and Dobzhansky (1946) state that their data from experimental populations were consistent with a hypothesis of large selective differences between the sexes. Later Dobzhansky (1950) found that the relative viability of male and female carriers of chromosomal variants was not always the same; in one of nine studies reported these differences were as extreme as the ones found here. Working with the arrangements of the "sex-ratio" condition in *D. pseudoobscura*, Wallace (1948) demonstrated that males and females differed in adaptive value at a number of stages in the life cycle. Similarly, selective mating which discriminates against mutant males but not against mutant females was found to be the cause of extinction of the gene for white eyes in populations of *D. melanogaster* containing its wild-type allele (Reed and Reed, 1950). Since Wallace and the Reeds were working with sex-linked conditions, however, their results are not strictly comparable to the data in this paper. For sex-linked conditions, males and females differ in gene dosage. Muller (1950a) presents evidence that genes present in single dose have weaker action than in double dose. Also, the increasing evidence that dominance is rarely complete (see citations and discussion by Muller, 1950b and 1950c) makes it questionable, even on genetic grounds alone, whether males hemizygous for a sex-linked dominant and females heterozygous for it present identical phenotypes for natural selection. In the present study, on the other hand, the genotypes of males and females should be identical with respect to the gene arrangements used (and the same holds for the data of Dobzhansky cited above). Nevertheless, there was considerable difference in the action of natural selection upon them. This may be the result of differences in the interaction of sex-linked modifiers with the genes included in these arrangements in the two sexes; or phenotypic differences may have arisen from the interaction of these genes with different extra-genic internal environments in males and females, analogous to the "sex-influenced" genes known in many animals (e.g., the gene for "pattern baldness" in man, which apparently causes baldness in males heterozygous for it, but not in such females (Gates, 1946)). The possibility exists also that the males and females with the same genotypes are phenotypically similar but meet different external environments. At first glance this seems hardly likely in a population cage, but there is evidence, for example, that the pH in a cage cup becomes progressively lower and that more males than females (as larvae and pupae) meet the more acid conditions.

It is well-known that under typical laboratory culture conditions more female *Drosophila* hatch from the puparia than do males. Thus, in their control counts Reed and Reed (1950) obtained 46.8% males and 54.2% females among 25,906 flies, the deviation from a 50:50 ratio being highly

significant. The females develop faster and therefore tend to exploit the available food supply better. One would expect an accentuation of this tendency in a population cup, where literally tens of thousands of larvae must compete for a food supply adequate to allow, at maximum, two or three hundred adults to emerge. The newly hatched populations of cage No. 16 (Table 3) conform to this expectation. On the other hand, the sex ratio does not deviate significantly from 50:50 among the flies hatching from the cups of cage No. 4. The cage 4 data thus reflect a lesser survival value of the females during preimaginal stages, perhaps related to the selection pressure against several female genotypes during this period noted in the text. Taken together with the observed differential mortality favoring the females during the adult stage, these results show that natural selection not only affects the sex ratio but also may influence it in different directions at different points in the life cycle. They call to mind yet another hypothesis of Darwin that has been the subject of little experimental study. Noting the many reports of animals (including man) with higher proportions of males at birth ("secondary sex ratio") but with greater mortality of males thereafter, so that females become proportionally more frequent in the adult (or tertiary) sex ratio, he suggested (1871) that for these species it would be a selective advantage to develop inherited mechanisms insuring that more males are born than females. Thus, selection favoring one sex at one stage of the life cycle would compensate for selection favoring the other sex at a different stage of the life cycle. Some evidence for this hypothesis does exist from studies of chicken mortality by Asmundson (1941). He found that in chickens most of the embryos dying during the last week of incubation were females. Nevertheless, the secondary sex ratio showed an excess of females, because a higher proportion of the embryos dying *before* the last week were males. How general the phenomenon might be remains questionable, however, for in the same author's work with turkeys, selection seemed to favor females throughout the embryonic period.

With respect to man, the significant excess of males at birth has generally been regarded as resulting from a discrepancy from the expected 50:50 ratio at conception (primary sex ratio). The argument has stemmed mainly from several studies of sex ratios among stillbirths (references in Stern, 1949, and McKeown and Lowe, 1951). These data have generally shown highly significant excesses of male stillborn embryos for every month of pregnancy for which data are available. Thus selection seems to favor females in the embryonic period as well as later. As Stern (1949) remarks: "Only if the greater weakness of the male sex were replaced in the earliest period by a greater weakness of the female sex, would the primary ratio be closer to equality than the ratio at two months of prenatal life. Such reversal of the relative mortality of the two sexes is most unlikely." Actually, such a flat statement of the case does not seem justified. For one thing there has been an increasing tendency to question whether the ones which can be examined are truly representative of all embryonic deaths, particularly since the largest proportion of all embryonic losses probably occur prior to or shortly after implantation and

can, therefore, rarely be examined (McKeown and Lowe, 1951). Also, the census data, which are the basis for many of the reports, have been criticized by many authors because the identifications as to sex were made by physicians and midwives, who are not particularly expert in identifying the sexes of early embryos. An additional factor which seems to have been overlooked in these discussions is that a greater number of males among the older stillbirths need not indicate a greater rate of mortality of males in these months of pregnancy; it may be only a manifestation of the already greater population of males present because of a greater rate of mortality of female embryos in the early months. For when two numbers are reduced by the same fraction, their ratio to one another remains constant. The relative uniformity of the stillbirth ratios in the later months seems to support this idea. As with so many other genetical problems of man and larger animals, it is likely that further progress on the sex ratio problem must await more evidence and suggestions of lines of attack from work with lower organisms, such as the populations of flies described in this paper.

SUMMARY

Experimental populations of *Drosophila robusta* differing in certain chromosomal arrangements yield quantitative evidence concerning natural selection. Selection appears to favor heterozygotes for the arrangements studied. In one population, the selection process in the females seems to consist of differential mortality between the egg and adult stages, whereas, the selection process in the males apparently occurs at a different stage of the life cycle. It is shown, for several populations, that a high excess of females among the adults is not primarily traceable to the eclosion sex ratio, but is, instead, the result of differential mortality favoring the females during the adult period. Possible genetic explanations for selective differences between the two sexes are outlined, and the present status of selectional explanations for variability in the sex ratio is discussed.

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Energy Dissipation in Vibrating Solids¹

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During the last 15 years or so, the study of energy dissipation in vibrating bodies has proved to be a very valuable technique for investigation of atomic and molecular deformation processes and for elucidating the mechanism of such processes. It is well known that freely vibrating bodies, such as a swinging pendulum, once set into motion will oscillate with a continually decreasing amplitude. Mechanical energy is thus gradually converted into heat energy. It might be expected that this decrease in amplitude, or loss of energy, is due to air resistance or to dissipation of energy at the supports. If the vibration takes place, however, in an evacuated space, and if every precaution is taken to eliminate or reduce as far as possible the energy transmitted to the supports, it is noted that the vibration still dies down in time. This dying down of amplitude, this capability of dissipating mechanical energy, is attributed to a property of the material itself, sometimes called damping capacity or internal friction. This property is a very significant one from the viewpoint of design. A material with large inherent damping capacity is better able to resist operation in the range of its own resonant frequencies than a material of low damping. It is for this reason that low carbon mild steels are frequently used in preference to higher strength alloy steels in some alternating load applications. It is not our intention here to dwell on the design significance of damping or internal friction measurements. Foppl (1936) and others have discussed this point at some length, and the importance of internal energy dissipation or damping under vibrational conditions is now well recognized by the design engineer.

MECHANISMS OF ENERGY DISSIPATION

Of great interest are the underlying mechanisms which are responsible for the conversion of mechanical energy into heat. Through the work of many researchers, of whom Zener (1948) has been one of the most prominent, it is now known that internal damping, or energy dissipation in vibrating solids, is very sensitive to structure and may arise from many different causes. Some of the important sources of energy dissipation are:

1) So called *thermoelastic damping* which may be of macroscopic or microscopic origin. It arises essentially from the fact that different parts of the vibrating object are at different stress intensities, and hence, the local temperatures vary, a temperature gradient exists, and irreversible heat flow takes place. Even if the average macroscopic stress is maintained constant across the specimen cross section, the actual stress intensities at different points will vary because of the random orientation of the

¹ Address delivered at the Scholars' Convocation, Randolph-Macon College, Ashland, Virginia on the occasion of the dedication of Smithey Hall, October 23, 1953.

individual crystallites and of their inherent anisotropies. The theory of damping due to thermal currents has been fairly well established by Zener and his co-workers, and the agreement with experimental evidence is excellent provided the amplitudes of motion are kept small.

2) Damping due to *stress-induced diffusion*. This type of energy dissipation occurs only in solid solutions and arises because application of stress biases the normal diffusion processes that take place. As a result, the material is characterized by a relaxation time corresponding to attainment of equilibrium conditions; a non-elastic component of strain accompanies application of applied stress; a hysteresis loop is present; and mechanical energy appears as heat. A great deal of information concerning the mechanism of diffusion itself can be obtained from studies of vibrational damping of alloys. Such tests can be carried out at room temperatures, whereas conventional diffusion experiments require much higher temperatures in order to get a measurable amount of diffusion. This means that the effect on diffusion of other variables such as number of vacancies, amount of cold work, etc., which are themselves affected by temperature, can effectively be best studied by vibration damping methods of the type now being discussed. For interstitial solutions, a theory has been developed and is in good agreement with experimental data. For substitutional solutions, no adequate theory is yet available (LeClaire, 1953).

3) Damping due to *slip at grain boundaries*. This type of damping occurs only in polycrystalline materials but can be found even in pure materials where stress-induced diffusion damping is absent. The process has been intensively studied by Ke (1947), Pearson (1951), and others but there is as yet no satisfactory theory of the phenomenon which agrees with the experimental results.

4) Damping due to *plastic flow*. This type of damping arises essentially because the stress-strain curve of the material in question is non-linear. Under alternating loading, a hysteresis loop is present, and energy is dissipated. Present evidence indicates that damping due to plastic flow is possible not only at engineering stresses where plastic behavior is to be expected, but also in some instances at very low strains or stresses where normally one would expect the material to be perfectly elastic. It is reportedly due to oscillatory motion of dislocations which are present in all materials but the precise mechanism is still not clear. The effect of various variables on the measured energy dissipation such as annealing, cold working, age hardening, etc. are easily studied by conventional methods and considerable information has been accumulated. As has been noted by Read (1940), Nowick (1953), and others, damping due to plastic flow is usually strongly dependent upon amplitude, whereas all three of the types discussed above, viz., thermal damping, diffusion damping, and grain boundary slip are all independent of amplitude but strongly dependent upon frequency.

5) Damping by *scattering of lattice waves*. This type of damping is significant only at very high frequencies in the megacycle region. The theory for this effect has been given by Mason (1947), who shows, by

analogy with the Rayleigh method for scattering of sound waves from inhomogeneities in gases, that the energy dissipation should vary with the 4th power of the frequency and the 3rd power of the grain size. This dependence has also been found experimentally.

6) *Viscoelastic damping.* This type of energy dissipation is analogous to viscosity losses in fluids and seems to be much more important in non-metallic solids such as high polymers or plastics. Various types of viscous models (Alfrey, 1948) such as the Maxwell Solid in which the deformation accompanying loading is irrecoverable and the Voight Solid, where the strain approaches a constant value asymptotically with time and recovers slowly on removal of the load, have been proposed to account for the observed losses. In general, it is found that the simpler models do not apply to the actual behavior of the solid and more complicated mechanisms have to be propounded.

METHODS OF MEASUREMENT

Let us set aside now this interesting aspect of mechanism and consider how one goes about measuring experimentally the inherent ability of materials to dissipate vibrational energy. This is not so easy to do as one might expect and the literature on the subject (Boulanger, 1949) is notable for the wide discrepancies in the reported values of damping. A direct measure of damping is the reduction in amplitude of a freely vibrating body. This reduction is usually expressed in terms of what is called the logarithmic decrement δ , which by definition is simply the log of the ratio of two successive amplitudes. To a first approximation this is the same as the fractional loss in amplitude per cycle or as $1/2$ the fractional loss in energy per cycle. It is not uncommon to find reported values of δ for the same material varying by a factor of 10^3 . It is also not uncommon to find great discrepancies in the reported variations of damping with amplitude, frequency, or temperature.

The discrepancies are due largely to three factors:

1) The presence of extraneous and unwanted losses such as acoustical losses and support losses. The first of these is easy to eliminate but the second is much more difficult, especially for low damping materials. One of the usual methods is to support the specimen by wire loops situated at the nodes. Another method (Brennan, 1953) developed in our laboratory at The Pennsylvania State University for use in the study of longitudinal vibrations of rods and tubes is to support the specimen on transverse reeds tuned to oscillate at the same frequency as the natural longitudinal frequency of the specimen. In this manner losses due to friction are kept very small and if necessary can be accounted for and separately determined.

2) Sensitivity of damping to structure and to past history of specimen. This sensitivity is frequently so great that the desired effect is masked by slight changes in structure and in method of handling or treating the specimen. For accurate and reproducible results therefore, the metallurgical structure and prior treatment must be rigidly controlled.

3) The presence of different mechanisms of energy dissipation in different frequency ranges. As mentioned before there are various possible causes for the conversion of mechanical energy of vibration into heat and these mechanisms do not necessarily possess the same amplitude or frequency dependence. Therefore the results of investigations made in different frequency regions can not be directly compared.

Once the appropriate precautions have been taken to avoid extraneous energy losses, there are still various methods that may be used to measure the inherent damping capacity. Which method is used will depend partly on the frequency range which it is desired to investigate. Some of the commonly used methods are:

a) Measure of the decay in amplitude in free vibrations. Results are usually reported in terms of a log decrement and have been obtained using longitudinal vibrations in rods, torsional oscillations of pendulums, and transverse oscillations of simple supported beams or cantilever reeds.

b) Measure of the resonance curve in forced vibrations. These forced vibrations may be induced mechanically, electromagnetically, piezoelectrically, or magnetostrictively, and the resultant strain detected in like manner. Usually one records the ratio of the width of the resonance curve

at half amplitude to the resonant frequency, and this ratio $\frac{\Delta F}{F}$ can be

shown to be directly proportional to the log decrement and to the fractional energy loss per cycle, provided the damping is small.

c) Measure of energy dissipation in forced vibration. This can be done by measuring the rate of temperature rise in the specimen during the forced oscillation or by determining the resonant amplitude and from this calculating the energy loss. The damping is usually expressed in terms of the ratio of the energy loss per cycle ΔW to the maximum energy W and it can be shown that $\Delta W/W$ in forced vibrations is the same as twice the log decrement in free vibrations provided damping is small.

d) Measure of attenuation in wave propagation. This is particularly suitable for very high frequencies. Provided damping is small, the attenuation constant can be expressed in terms of the fractional energy loss per cycle or in terms of the log decrement.

BRIEF REVIEW OF DATA

The data on internal friction is far too extensive to review adequately in any one lecture. Some of the significant findings are as follows:

1) Measured values of δ are of the order of

10^{-6} for quartz

10^{-3} to 10^{-5} for metals

10^{-2} to 10^{-3} for glass

10^{-1} to 10^{-2} for high polymers

These are only approximate values but the general trend of increasing

the energy absorption ability as we go from the highly crystalline materials to the amorphous or polymeric substances is significant.

2) In many instances, the experimental investigation reveals a peak in the δ vs. T curve, or the δ vs. f curve. This would indicate that some type of anelastic mechanism is present and that some atomic or thermal rearrangement characterized by some relaxation time is taking place. In these cases, it is usually expected δ will be independent of amplitude though in many experiments the question of amplitude dependence has not been investigated.

3) In other instances, the investigator finds little or no frequency dependence but a noticeable dependence on amplitude. This would appear to indicate a form of hysteresis loss due to plastic flow or essential non-linearity in the stress-strain curve. It is believed to be due to the motion of dislocations but there is as yet no valid theory of the phenomenon.

4) It seems clear that internal energy dissipation in vibrating solids is not viscous in character since ordinary viscosity leads to a direct dependence on frequency for a Voight Model and an inverse dependence upon frequency for a Maxwell Model, and neither is obtained experimentally. A more complicated model, usually referred to as a "Standard Linear Solid" and characterized by having some parameter such as the anelastic strain

(ϵ_{an}) approach equilibrium in exponential fashion $\epsilon_{an} = \epsilon_{an}^0 (1 - e^{-t/\tau})$ does lead to a frequency dependence of the energy dissipation of the form.

$$\delta = C \frac{\omega \tau}{1 + \omega^2 \tau^2}$$

where C and ϵ_{an}^0 are constants, ω is the frequency, t the time, and τ the time of relaxation. This relation is approximated by the observed behavior of some materials--especially at low stress amplitudes where amplitude dependence is not generally found. Qualitatively what happens in such a system is the following: if the frequency is very high, internal rearrangements do not have time to take place; no anelastic strain is produced, and no hysteresis occurs. On the other hand, if the frequency is very low, the system is essentially in equilibrium at each stress; the strain is in phase with stress; and no hysteresis develops. For intermediate frequencies, where the period of oscillation is comparable to the relaxation time, there is an appreciable amount of anelastic strain present, and mechanical energy is dissipated as heat.

5) The effect of annealing on energy dissipation is exactly reversed depending on whether one is considering low amplitude internal friction or high amplitude internal friction. For low amplitudes, annealing reduces δ presumably because dislocations diffuse out in the annealing process; in the high amplitude case, annealing increases δ and cold work decreases δ . Here it is thought that work hardening increases the elastic action of the material and reduces the amount of plastic flow, thus decreasing the size of the hysteresis loop.

RECENT AND CURRENT RESEARCH AT PENNSYLVANIA STATE UNIVERSITY

A number of different research projects in this general field of energy dissipation of vibrating solids have been underway at this University in recent years. They include:

1) Development of an apparatus to produce high stresses at audio-frequencies. Heretofore, all measurements at high stresses have been made at low (mechanical) frequencies and all measurements at high frequencies have been at low stresses. In our newly developed apparatus, a stress range from 100 psi to 7,000 psi has been studied. For aluminum alloys, it has been noted that, throughout this large stress range, the value of damping remains very small ($\delta \sim 10^{-5}$) and there is a noticeable dependence of damping on amplitude (Sauer and Brennan, 1953). The dependence on amplitude was found to be very similar to that observed in a previous low frequency investigation (Sauer *et al.*, 1949) in which a mechanical resonant oscillator was used. Additional features of the Pennsylvania State University longitudinal apparatus are: losses at the supports can be separately determined and accounted for if necessary, and the losses are themselves kept very small by making the supports out of resonant reeds tuned to oscillate at the same frequency as the natural longitudinal frequency of the specimen.

2) By means of a transverse vibration method, the dependence of δ on temperature for a group of high polymers in the lower audio-frequencies is being explored. Some tests have been run at liquid air temperatures and it is expected that much lower temperatures will be reached in the near future. There is some indication from preliminary unpublished work done at the Research Laboratories of the Imperial Chemical Industries in England that resonant peaks may be present in these low temperature regions.

3) Velocity and attenuation measurements are being made in the frequency range of 100 kc. to 1 megacycle using barium titanite transducers and a pulse technique. The critical region in which λ is comparable to the dimensions of the bar, and for which no theoretical solution for the propagation velocity exists is being explored.

4) The contribution to damping caused by finite thermal conductivity has been investigated theoretically (Lessen and Duke, 1953) for the case where the path for heat flow is not fixed but is itself a function of frequency. A single equation for propagation of a stress disturbance has been obtained; for the isotropic case it can be shown that a shear wave is undamped but that the medium is dispersive to longitudinal vibrations as different components propagate at different velocities and hence the wave form is not preserved. It can also be shown that the effect of frequency (ω), is the same as the effect of thermal conductivity (K) i.e. as $K \rightarrow \infty$ or $\omega \rightarrow \infty$ one gets the isothermal solution and as $K \rightarrow 0$ or $\omega \rightarrow 0$ one gets the adiabatic solution.

5) An attempt (Sauer and Oliphant, 1949) has been made to introduce damping capacity data as well as fatigue data into the mechanics of

design of resonant members. This study shows that in such applications materials of lower fatigue strength may be more suitable because of higher inherent damping than materials of high fatigue strength.

CONCLUSIONS

Much useful information both for the engineer and the physicist results from studies of energy dissipation in vibrating solids. Some of the benefits accruing from such studies are:

1) Needed information for engineering design purposes is provided, especially for design of resonant members in which damping is more important than strength.

2) More accurate values of the diffusion constant in solid solutions have been obtained and over a much greater range of temperature than was heretofore possible by conventional diffusion measurements alone; activation energies for the responsible mechanism can be estimated; the role played by vacancies in diffusion processes can be studied; and the mechanism of precipitation can be made more definite.

3) Knowledge of grain boundary movements, or activation energy for grain boundary slip, and of effect of impurities can be deduced.

4) The part played by dislocations and lattice imperfections in plastic flow can be investigated. For example, it can be shown that dislocations must be of at least two types: one responsible for hardness, the other for internal friction effects. This conclusion is deduced from the fact that the measured value of the energy dissipated can be greatly affected by heat treating and annealing operations that have almost no effect on hardness.

5) An understanding is gradually being developed of the underlying mechanisms responsible for the energy loss and for the atomic and thermal rearrangements that are involved. There are, however, still many unexplored questions and much work needs to be done, both of an experimental and theoretical nature, before energy dissipation in vibrating solids can be said to be a well established and well understood branch of physics.

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The Distribution of Poisonous Snakes in Virginia

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Reported here are records showing the distribution of venomous snakes in Virginia. Prior to 1940 there was only incidental mention of poisonous snakes in this State.¹ In 1940 Gloyd was only able to verify six specific localities in Virginia where timber rattlesnakes had been collected, and the distribution of the cane-brake rattlesnake was based on Brady's (1927) heresay report. Presumably on the basis of specimens, Gloyd and Conant (1943) reported copperheads in 12 localities and cottonmouth moccasins in two. Subsequently a number of reports² specify localities in Virginia where poisonous snakes have been observed or collected. These reports have not been summarized previously, and little is known of the distribution of poisonous snakes in Virginia. This accounts for the recent erroneous reports that rattlesnakes are rare in Virginia (Roper, 1951), and that Virginia has only three native poisonous snakes (Taylor, 1952).

Schmidt and Davis (1941) list five venomous snakes in Virginia, as follows: northern copperhead, *Ancistrodon contortrix mokeson* (Daudin); southern copperhead, *Ancistrodon contortrix contortrix* Linnaeus; cotton-mouth moccasin, *Ancistrodon piscivorus piscivorus* Lacepede; timber rattlesnake, *Crotalus horridus horridus* Linnaeus; and cane-brake rattlesnake, *Crotalus horridus atricaudatus* Latreille. Gloyd and Conant (1943) failed to find typical southern copperheads in Virginia, and indicated that these snakes in the southeastern counties are actually intergrades between the northern and southern subspecies. With this single alteration in the above list, the above species constitute our native poisonous snakes.

Two other venomous snakes are frequently reported in Virginia. The coral snake, *Micruurus fulvius fulvius* Linnaeus, was erroneously reported as a native species by Barringer (1892). No coral snakes have been collected or observed in Virginia by herpetologists, and none are in museum collections. Barringer undoubtedly made the common mistake of regarding the "false coral" or scarlet king snake, *Lampropeltis elapoides virginiana* Blanchard, as the dangerous species. The eastern diamond-back rattlesnake, *Crotalus adamanteus* Beauvois, was listed as a possible member of the Dismal Swamp fauna by Brady (1927) but he saw no specimens. Neither of these snakes is known north of the lowlands near Albemarle Sound, North Carolina.

¹ The following contain incidental mention of Virginia poisonous snakes: Barringer, 1892; Blane, 1824; Brady, 1927; Ditmars, 1935; Dunn, 1915-a, b, c and 1918; Gloyd, 1934; Lynn, 1936; Medden, 1931; Rocheouault, 1800; Spooner, 1793; Uhler, Cottam, and Clarke, 1939.

² Recent literature listing localities where poisonous snakes have been found in Virginia include: Anon., 1953; Clarke, 1953; Goodwin, 1951; Hoffman, 1945 and 1953; Smyth, 1949; and Werler and McCallion, 1951.

The distribution of Virginia poisonous snakes is considered on the basis of the faunal zones defined by Clark and Clark (1951), Map 1. The Coastal Section, consisting of Princess Anne and Norfolk counties, has not been distinguished from the Lower Austral zone because the venomous snake faunae in these two areas are identical. The faunal zones (Map 1) are as follows:

1. Coastal Section and Lower Austral occupy the southeastern counties including part of Gloucester, most of the lower York-James peninsula, and all of the region south of the James River and east of the fall line;
2. Upper Austral consists of the Piedmont, the upper Coastal Plain including the eastern shore counties, the floors of the valleys in the northwestern counties, and the majority of Lee County in the southwestern corner of the state;
3. Transition zone includes the highlands and mountains of the Blue Ridge and Appalachians between 1,500 and 4,000 feet elevation in the north, and 2,000 and 4,500 feet in the south;
4. Canadian zone includes elevations above the limits of the Transition zone, and consists of a few mountain tops in Augusta, Grayson, Highland, Montgomery, and Washington counties.

The distribution of Virginia poisonous snakes has been mapped from data from four sources, including literature records, museum specimens, herpetologists' and naturalists' observations, and medical records of locations where snake-bite accidents have taken place.

Museums and private collections provided 91 locality records based on preserved material including data on 75 copperheads, 7 cottonmouth moccasins, 21 timber rattlesnakes, and 8 cane-brake rattlesnakes. In the locality lists the identity of the sources of the data are indicated with initials and catalog numbers of specimens. The initials of museums and private collections, and the institutions or persons they identify, are as follows:

AMNH—American Museum of Natural History; ART—A. R. Turner, Portsmouth, Va.; CAS—Chicago Academy of Science; CM—Carnegie Museum; CMNH—Chicago Museum of Natural History; JAF—J. A. Fowler, Philadelphia, Penn.; JTW—J. T. Wood, Williamsburg, Va.; MCZ—Museum of Comparative Zoology; OKG—O. K. Goodwin, Warwick, Va.; RFC—R. F. Clarke, Emporia, Kansas; SNP—Shenandoah National Park collection, Luray, Va.; UMMZ—University of Michigan Museum of Zoology; USNM—United States National Museum.

Herpetologists and naturalists reported 295 poisonous snakes from 236 localities. Their reports included locality data giving the distribution of 128 copperheads, 20 cottonmouths, 124 timber rattlesnakes, and 23 cane-brake rattlesnakes. The identity of these observers is indicated in the locality lists by initials with punctuation, and not followed by numbers. All of these observers provided incidental data including dates of observations, character of habitats, and in some cases, behavior and natural history observations. The initials, names, and addresses of the observers are as follows:

A.R.T.—A. R. Turner, Portsmouth, Va.; **C.C.S.**—C. C. Steirly, Waverly, Va.; **C.H.S.**—C. H. Shaffer, Lynchburg, Va.; **C.P.G.**—C. P. Gilchrist, Tappahannock, Va.; **E.D.H.**—E. D. Harris, Norfolk, Va.; **E.V.R.**—E. V. Richards, Keezletown, Va.; **G.B.P.M.**—G. B. P. Mullin, Roanoke, Va.; **H.G.M.J.**—H. G. M. Jopson, Bridgewater, Va.; **H.S.H.**—H. S. Hedges, Charlottesville, Va.; **J.W.E.**—J. W. Engle, Staunton, Va.; **O.K.G.**—O. K. Goodwin, Warwick, Va.; **P.J.H.**—P. J. Hanlon, Harrisonburg, Va.; **P.G.F.**—P. G. Favour, Luray, Va.; **P.M.P.**—P. M. Patterson, Hollins, Va.; **P.R.B.**—P. R. Burch, Radford, Va.; **P.W.S.**—P. W. Sundheimer, Roanoke, Va.; **R.C.**—Roger Conant, Philadelphia, Penn.; **R.F.C.**—R. F. Clarke, Emporia, Kan.; **R.H.C.**—R. H. Cross, Roanoke, Va.; **R.H.M.**—R. H. Manville, Lansing, Mich.; **R.H.R.**—R. H. Rageot, Norfolk, Va.; **R.J.B.**—R. J. Bartholomew, Portsmouth, Va.; **V.D.M.**—V. D. McManus, Williamsburg, Va.; **W.G.L.**—W. G. Lord, Roanoke, Va.; **W.H.M.**—W. H. Massmann, Gloucester Point, Va.; **W.L.B.**—W. L. Burger, Champaign, Ill.; **W.M.W.**—W. M. Wallenborn, Charlottesville, Va.; **W.P.B.**—W. P. Blackwell, Orange, Va.

Medical records of snake-bite accidents have contributed 116 locality records to this survey. These include records of bites by 101 copperheads, 12 timber rattlesnakes, two cane-brake rattlesnakes, and one cottonmouth moccasin. In the lists of snake-bite accident locations the initial of the hospital and record number of the case are cited after the locality is listed. The initials of hospitals and clinics, followed by the name and address of each institution, are as follows:

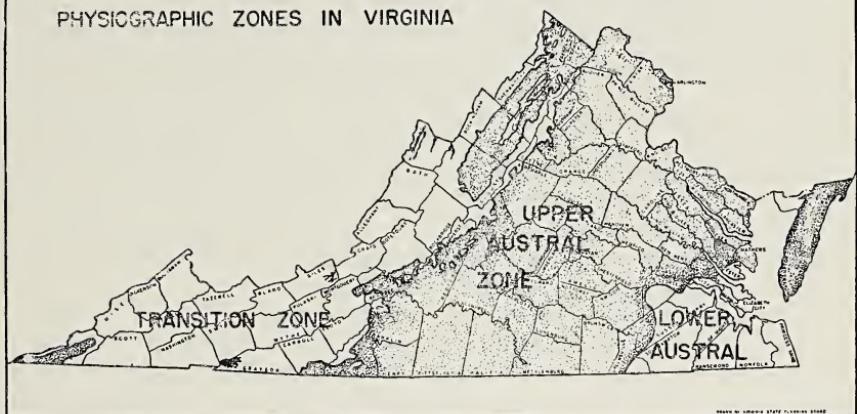
BH—Bell Hospital, Williamsburg; **C-OH**—Chesapeake and Ohio Hospital, Clifton Forge; **CVCH**—Clinch Valley Clinic Hospital, Richlands; **DePH**—DePaul Hospital, Norfolk; **GCH**—Gordonsville Community Hospital, Gordonsville; **JMH**—Johnston Memorial Hospital, Abingdon; **LGH**—Lee General Hospital, Pennington Gap; **LyGH**—Lynchburg General Hospital, Lynchburg; **MCV**—Medical College of Virginia Hospitals, Richmond; **MJH**—Martha Jefferson Hospital, Charlottesville; **MWH**—Mary Washington Hospital, Fredericksburg; **N-AMH**—Northampton-Accomack Memorial Hospital, Nassawadox; **NGH**—Norfolk General Hospital, Norfolk; **RMH**—Rockingham Memorial Hospital, Harrisonburg; **SBMNH**—Susan B. Miller Nursing Home, Woodstock; **StMH**—St. Mary's Hospital, Norton; **USNH**—United States Naval Hospital, Quantico; **UVH**—University of Virginia Hospital, Charlottesville; **WMH**—Warren Memorial Hospital, Front Royal.

The presence of venomous snakes in Virginia has been mentioned in 31 papers listed at the end of this report. Those including locality data have been used for additional distribution points. All localities based upon published records are followed in the lists by the author's name, and the year the record was published. A total of 522 distribution records have been obtained from sources other than published literature. Together these comprise the basis of the distribution maps.

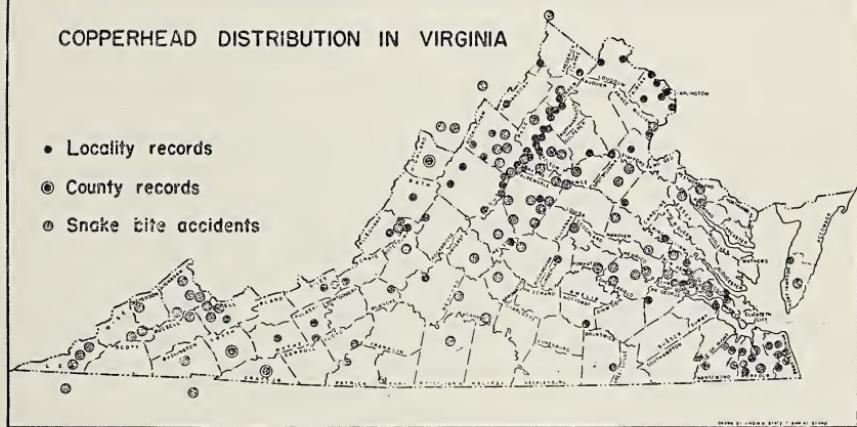
COPPERHEADS

The vertical distribution of copperheads in Virginia ranges from a few feet above sea level in Princess Anne County to 4,500 feet in the mountain counties. Copperheads are found in all regions of Virginia, but they are unequally distributed through the physiographic provinces. From data compiled in this survey it appears that copperheads are absent in the Canadian zone; uncommon in the higher elevations of the Transition zone, and common on the lower slopes; and widely distributed in all other zones (Upper Austral, Lower Austral, and Coastal Section). Generally they are absent or rare in urban areas, uncommon in suburban areas, and relatively common in rural regions. Most of the museum specimens, literature records, and naturalists observations verify the presence of copperheads in the recreation areas, national and state parks, public forests, and wild regions. Most of the copperhead bites do not take place in these regions, but are recorded where farming and lumbering activities are common, and are frequent near rural dwellings and farms.

PHYSIOGRAPHIC ZONES IN VIRGINIA



COPPERHEAD DISTRIBUTION IN VIRGINIA



MAP 1. (Above). Faunal life zones in Virginia: *Lower Austral* and *Coastal Section* in the southeastern counties; *Upper Austral* in the stippled areas; *Transition Zone* in the western and southwestern counties; and *Canadian Zone* in the solid black areas in the Transition Zone. (After Clark and Clark, 1951).

MAP 2. (Below). The distribution of copperheads and snake bite accidents caused by copperheads in Virginia and its extra-limital areas.

As Roper (1951) pointed out, copperheads appear to be common in Virginia. They are locally abundant in the following mountain counties: Alleghany (Hoffman, 1945), Clarke (Dunn, 1915-c), and Nelson (Dunn, 1915-a). A series of 72 specimens were collected in George Washing-

ton National Forest (Uhler, Cottam, and Clarke, 1939). As the result of extensive field work of National Park naturalists they have been found to be locally abundant in areas scattered along the Skyline Drive and the Blue Ridge Parkway (P. G. Favour, personal communication, March 27, 1953; W. G. Lord, personal communication, March 31, 1953). It is probable that copperheads are locally abundant in all mountain counties. The snake-bite records show that copperheads are widely distributed in the Piedmont counties, and they are cited as abundant in Nottoway (Hoffman, 1953) and Stafford (Lynn, 1936). Although they are apparently uncommon in Princess Anne County (Werler and McCallion, 1951), and most of the remaining Coastal Plain, they are the commonest and most widely distributed poisonous snakes in eastern Virginia.

Copperheads are found in all states bordering on Virginia. They are common in the valleys and low slopes of Harlan County, Kentucky (Barbour, 1950), not uncommon near Raleigh, North Carolina (Brimley, 1923), abundant in the mountains and Piedmont of Maryland, while uncommon over most of the Coastal Plain (McCauley, 1945), and they are reported "occasionally found" in at least two West Virginia counties, Randolph (Green, 1937) and Hardy (Wilson and Friddle, 1950).

Copperheads in the mountain counties gather in the vicinity of overwintering "dens" with blacksnakes and timber rattlesnakes during the fall months. According to Dr. P. R. Burch (personal communication, August 14, 1953) "dens" have been found at elevations ranging from 1700 to 4500 feet; in some dens the rattlesnakes considerably outnumber the copperheads. Burch adds, "All dens I have seen have been on wooded mountainsides with southeastern exposures.—(Dens consist) of weathered outcroppings of rock — with deep crevices which permit the snakes to retreat to a considerable depth below the surface." Individuals have been observed lying on sunlit rock ledges in these areas during spring and fall months. It has recently been reported by Finneran (1953) that in some regions females gather at dens in late summer and early fall, presumably near the time of completion of the gestation period. This has not been reported in Virginia.

Copperheads living in the Coastal Plain are reported to overwinter singly (Neill, 1948). An adult female and two young juveniles were discovered in hibernation by Mr. O. K. Goodwin (personal communication, September 15, 1953). Nothing is known of the over-wintering of copperheads in the Piedmont counties.

The duration of the season of activity of copperheads in Virginia has not been well defined from the compiled field observations, but some appreciation of its extent may be obtained from the following reports. In the highlands of Shenandoah National Park copperheads have been seen in the open from April 16 to December 12, but it is uncommon there to find specimens in the field earlier than May, or later than September (P. G. Favour, personal communication — March 27, 1953). The number of specimens observed in October and November is considerably greater than the number seen in April, indicating that the time of retreat into hibernation is more variable than the time of emergence. On the Coastal

Plain copperheads have been found active on October 26 (Roger Conant, personal communication — March 26, 1953) and still in hibernation on March 16 (O. K. Goodwin, personal communication — March 15, 1953).

The mating of copperheads is preceded by a "combat dance" between males (Gloyd, 1934; 1947). This takes place in spring. The period of gestation is completed in the fall; three records indicate that birth of young occurs in September [Nelson County, September 1st (Dunn, 1915-b); Rappahannock County, September 26, and Greene County, September 28 (P. G. Favour, personal communication, March 27, 1953)]. The number of young produced by one female has been reported for two of the broods as six and seven; in the remaining case two gravid females were confined in one cage, and produced a total complement of 12 young on the same day.

From May through September, Virginia copperheads usually remain in concealment by day, and roam or forage at night. When they are exposed in their diurnal retreats they usually vibrate their tails, and briefly remain alert and motionless. They then slowly retreat into other concealment. If injured, molested, or frightened by sudden motions they may strike. They are frequently found in wood piles, slab heaps, and old stone walls. They feed on mice, caterpillars, and shrews (Uhler, Cottam, and Clarke, 1939).

DISTRIBUTION OF COPPERHEADS BY COUNTIES, MAP 2

[188 Localities]

ALBEMARLE: Campbell (UVH-149869); Charlottesville (W.M.W.) (UVH-124771, 356627); Covesville (UVH-354369); Crozet (UVH-243545, 231504); Keswick (UVH-120607); Rio (UVH-77926); Scottsville (MJJ-45924, UVH-286214).

ALLEGHANY: Clifton Forge (C-OH 56036); 2 mi. W of Clifton Forge (USNM 127600); 3 mi. N of Clifton Forge (CM 28216); North Mtn., 12 mi. E of Clifton Forge (UMMZ 84321); Little Middle Mtn., 6 mi. N of Clifton Forge (USNM 124781).

AMHERST: Amherst (LyGH-18054, 57957).

APPOMATTOX: Appomattox (LyGH-16691).

ARLINGTON: Between Chain Bridge and Falls Church (USNM 95192).

AUGUSTA: 3 mi. N of Rockfish Gap, SNP (W.M.W.); Calfpasture River (P.J.H.); Horsehead Overlook, SNP (SNP-16); Lithia Spring (USNM 36763); North River (E.V.R.); Sherando Lake area (H.G.M.J., O.K.G.); Stribling Spring (USNM 36780).

BATH: Warm Springs Mtn. (H.G.M.J.).

BEDFORD: Little Stony Creek, BRP (W.G.L.).

BOTETOURT: Eagle Rock (C-OH 59061); North Creek (P.W.S.); Roaring Run Gap (USNM 127650).

BRUNSWICK: 4 mi. E of Brunswick (UMMZ 84319).

BUCHANAN: Council (CVCH-43802); Pilgrim's Knob (CVCH-49590, 64180); Roseann (CVCH-37901, 61992); Whitewood (CVCH-12987, 48001, 62662).

BUCKINGHAM: Manteo (UVH-256846).

CAMPBELL: Brookneal (LyGH-19091); Evington (LyGH-53170).

CAROLINE: Chilesburg (USNM 48876-77).

CHARLES CITY: Holdcroft (MCV-4851); 1.5 mi. W of Chickahominy River Bridge, nr James River (O.K.G.) (JTW-3104); Roxbury (MCV-118675); 4 mi. W of Chickahominy River Bridge, Rt. 5 (JTW-3515); 8 mi. W of Chickahominy River Bridge (J.T.W.).

CHESTERFIELD: Hallsboro (MCV-9901); Richmond (MCV-130398); Winterpock (MCV-86442).

CLARKE: White Horse, 2 mi. above Berry's Ferry (Dunn, 1915-a).

CRAIG: Barbour's Creek (P.W.S.); John's Creek Mtn., near Maggie (P.R.B.).

CULPEPER: Rappidan River (USNM 84151, 84170); Rappahannock River, 1 mi. above jct. with Rappidan R. (H.S.H.).

CUMBERLAND: State Forest (C.H.S.).

- DICKENSON:** Clintwood (StMH-10347, 10576).
- ESSEX:** Loretta (MCV-29437).
- FAIRFAX:** Alexandria (USNM 10374); Dead Run nr Cabin John (USNM 35734); Elkins (USNM 62062); Great Falls (USNM 25817, 49994, 55410); opposite Plummer's Island (USNM 49721); Waples Mill Road (USNM 117559).
- FLOYD:** Smart View picnic area, BRP (W.G.L.); Mile 157, BRP (W.G.L.).
- FRANKLIN:** 8 mi. S of Rocky Mt. (C.H.S.).
- FREDERICK:** Vances Cove, Paddy Run (E.V.R.).
- GILES:** Mtn. Lake Biological Station (P.M.P., AMNH 69601); 2.3 mi. N of Mtn. Lake Biol. Sta. (CMNH 56496).
- GOOCHLAND:** Caledonia (UVH-228822).
- GRAYSON COUNTY:** County record (R.H.C.).
- GREENE:** Loft Mtn. Overlook, SNP (P.G.F.); Simmons Gap, SNP (P.G.F.); So. River Falls Trail, SNP (P.G.F., R.H.M.); Stanardsville (UVH-254825); Swift Run Gap, SNP (JTW 2332).
- HANOVER:** Beaverdam (MCV-86671); Mechanicsville (MCV-118511).
- HENRICO:** Richmond (MCV-4278, 86545, 118077, 130398).
- HENRY:** Spencer (CM 18085).
- HIGHLAND:** County record (J.W.E.).
- ISLE OF WIGHT:** 1 mi. E of Franklin (R.J.B.).
- JAMES CITY:** Williamsburg (MCV-34023; BH-200303; JTW 2334,3103,3208); 4.5 mi. W of Lee Hall (J.T.W.); Dunbar area, Williamsburg (JTW 895); Lake Matoaka Park, nr Williamsburg (W.L.B.).
- KING WILLIAM:** Palls P. O. (MCV-91361); Manquin, nr Pamunkey River (W.H.M.; JTW 2714).
- LEE:** Calvin (LGH-28220); Jonesville (LGH-23467); Pennington Gap (LGH-25497, 30797).
- LOUDOUN:** Bluemont (USNM 51893); Leesburg (USNM 10361).
- MADISON:** Graves Mills P. O. (UVH-296935, 358721); Hughes River Gap, SNP (P.G.F.); Madison (UVH-163748) nr Skyland entrance road, Skyline Drive, SNP (P.G.F.); Rapidan River camp, SNP (R.H.M.); Spitler Knob Overlook, SNP (P.G.F.).
- MATHEWS:** Bayside (NGH-35931).
- NANSEMOND:** Buckhorn P. O. (R.H.R.); Dismal Swamp (USNM 26263); Lake Prince area (R.F.C.); 2 mi. NW of Suffolk (R.F.C.).
- NELSON:** Lovington (UVH-44155, 248610); 40 mi. below Lynchburg on James River (Dunn, 1915-a).
- NEW KENT:** Quinton (MCV-4819, 4231); Walkers (CM 30691); 5 mi. N of Diauscund Bridge (CM 30695).
- NORFOLK:** near Norfolk (Buckley, 1953); Hickory (DePH-3936); Bowers Hill (ART-59); 1-2 mi. N of Deep Creek (R.F.C.); Hodges Ferry (ART-517); 1 mi. N of Hodges Ferry (R.F.C.); Lake Drummond, E shore (R.J.B.); Lake Drummond, N shore (R.J.B.).
- NORTHAMPTON:** Jonesville (R.C.); Northampton (N-AMH-2336594).
- NOTTOWAY:** Camp Pickett (USNM 131925).
- ORANGE:** Barboursville (GCH-5889); Gordonsville (GCH-7217); Hawfield Farm (W.P.B.); Rapidan (GCH-8726).
- PAGE:** Bushy Top, SNP (P.G.F.); near Luray (UVH-204338, 204339); Skyland, SNP (AMNH 8594); Thornton Gap, SNP (USNM 59880).
- PATRICK:** Rock Castle Gorge near Rocky Knob camping area, BRP (W.G.L.).
- PITTSYLVANIA:** Gretna (LyGH-16982).
- POWHATAN:** Clayville (MCV-119702).
- PRINCE GEORGE:** near Petersburg (Anon, 1953).
- PRINCE WILLIAM:** near Dumfries (JAF-1132); Quantico (USNH-33536).
- PRINCESS ANNE:** Pungo (ART-514); 3 mi. SW of Pungo (CM 22944-46); West Neck Creek, Pungo Twp. (Werler and McCallion, 1951); 2 1-4 mi. E of Princess Anne (CM 23212); Princess Anne Twp. (Werler and McCallion, 1951); 2 mi. NW of Kempsville (J.T.W.); 4 mi. W of Virginia Beach (Werler and McCallion, 1951).
- PULASKI:** Towes Ferry, near Newbern (R.P.B.); Radford College Farm (P.R.B.).
- RAPPAHANNOCK:** Buck Hollow Overlook, SNP (P.G.F.); Elkwallow Gap, SNP (P.G.F.); Hogwallow Flat Overlook, SNP (P.G.F.); entrance to J. Gray Fire Road, SNP (P.G.F.); Rangeview Cabin, SNP (P.G.F.).
- RICHMOND:** Farmer's Fork (MWH-8950).
- ROANOKE:** 1-2 mi. S of Hollins (P.M.P.).
- ROCKBRIDGE:** Arnold's Valley (P.W.S.).
- ROCKINGHAM:** Big Run Overlook, SNP (RHM-96833); Bridgewater (H.G.M.J.); Broadway (RHM-89741); Briery Branch (H.G.M.J.); 6 mi. N of Grottoes (JTW 3105); Harrisonburg (RMH-67313, 97782); Keezletown (RMH-103599, 121551); Mt. Crawford (RHM-

67196); Rocky Bar, Elkton (RHM-67684); Simmons Gap, SNP (P.G.F.); Singer's Glen (USNM 37784); Swift Run (RMH-81858, 98096).

RUSSELL: Drill (CVCH-14563).

SHENANDOAH: Orkney Springs (USNM 48529).

SMYTH: County record (R.H.C.).

SPOTSYLVANIA: Fredericksburg (MWH-9704); Spotsylvania (MWH-9480).

STAFFORD: Onville, near Aquia Creek (Lynn, 1936).

SURRY: Hog Island (C.P.G.).

TAZEWELL: Amonate P. O. (CVCH-12019); Bandy (CVCH-7966, 25962); Freestone Valley (P.W.S.); Jewell Ridge (CVCH-13806, 21274, 55048); Jewell Valley (CVCH-56002); Raven (CVCH-31765).

WARREN: Mile 9, Skyline Drive, SNP (P.G.F.); Riverton (WMH-3719).

WARWICK (CITY): 2 mi. NW of Lee Hall (JTW 1002).

WASHINGTON: Abingdon (JMH-50585, 51979).

WESTMORELAND: Montross (MCV-68452).

WISE: Esserville (StMH-3101); Wise (StMH-10430).

WYTHE: Iron Mtn. (P.W.S.).

YORK: 9 mi. W of Yorktown, Colonial Parkway (JTW 2333); 1-2 mi. N of Williamsburg, Rt. 60 by-pass (JTW 1498); 1 1-2 mi. E of Williamsburg, Colonial Parkway (JTW 1494).

Abbreviations not mentioned previously:

SNP—Shenandoah National Park; **BRP**—Blue Ridge Parkway.

DISTRIBUTION OF COPPERHEADS (EXTRA-LIMITAL COUNTIES) (MAP 2)

HANCOCK COUNTY, TENNESSEE: Sneedville (LGH-25982). **JOHNSON COUNTY, TENNESSEE:** Mountain City (JMH-47628). **HARDY COUNTY, WEST VIRGINIA:** Petersburg (RMH-90672). **MORGAN COUNTY, WEST VIRGINIA:** Cacapon State Park (J.T.W.). **PENDLETON COUNTY, WEST VIRGINIA:** Cherry Grove (RMH-87754); Franklin (RMH-128130).

COTTONMOUTH MOCCASINS

In Virginia cottonmouth moccasins are confined to the counties south of the James River and east of Petersburg. They are known to be common in a few localities in this range, Map 3, all situated in either Princess Anne or Norfolk counties. They are found in North Carolina counties bordering the region of known their range in Virginia, and are absent from all other extra-limital counties.

Werler and McCallion (1951) report cottonmouths as common near West Neck Creek, Princess Anne County. They are also common in the Northwest River, Norfolk County, and in the vast bayside swamps along the barrier beach, where they are separated from the mainland by a series of brackish bays.

The earliest date on which cottonmouths have been seen in Virginia in the records of this survey is April 26, but they have been observed as late as December 4. Neill (1948) reports that they hibernate late in the year in Georgia; nothing is known of the time of hibernation in Virginia. Several observers have reported migratory behavior of the cottonmouths from the bayside swamps of barrier beach to the mainland in late October and early November. In a period of as little as three or four days as many as 50 specimens have been observed swimming across Back Bay in the vicinity of the wildlife refuge. This seemingly gregarious behavior may be related to the hibernating habits, but to date nothing is known of the over-wintering of this species in Virginia. In Georgia they hibernate singly (Neill, 1948), and in Mississippi during the hiberna-

tion period they are usually found under logs and stumps in the vicinity of their summer habitat (Allen, 1932). They do not appear to overwinter near their summer habitat in the Back Bay region of southeastern Virginia.

During their active season cottonmouths are found in habitats providing a permanent body of water and inaccessibility to man. The water area may be sluggish or still, and is often associated with a bay or swamp. Cottonmouths do not range far from water, and are frequently found sunning on horizontal limbs overhanging the water. From these sites they can drop into the water when they become alarmed. Cottonmouths feed on fish, frogs, turtles, snakes, birds, and small mammals (Parker, 1937); Smith, 1950). Courtship activities and the "combat dance" of this species occur in spring months, probably March and April in Virginia (Carr and Carr, 1942; Smith, 1950).

DISTRIBUTION OF COTTONMOUTH MOCCASINS BY COUNTIES, MAP 3
[25 Localities]

NANSEMOND: 6 1-2 mi. S of Suffolk (R.C.); Cypress Chapel (R.C.); Dismal Swamp (Clarke, 1953).

NORFOLK: 1-2 mi. N of Deep Creek (RFC-62); Lake Drummond (R.F.C.); 5 mi. S of Deep Creek (RFC-17); South Norfolk (E.D.H.); North Landing (R.F.C.); 1-2 mi. W of North Landing (R.C.); Northwest (RFC-614); 1-2 mi. E of Northwest (A.R.T.); 3 mi. NE of Northwest (R.J.B.).

PRINCE GEORGE: Petersburg area (Anon., 1953).

PRINCESS ANNE: Back Bay (H.G.M.J.) (C.H.S.); Barrier beach area (Werler and McCallion, 1951); False Cape, 5 mi. N of state line (CM-22990); Munden (C.P.G.); North Landing (C.P.G.); Princess Anne, 1 mi. E (CM-23215); Princess Anne Twp. (Werler and McCallion, 1951); Sand Bridge (MCZ 45317); Seashore State Park (CM 23620); West Neck Creek, Pungo Twp. (Werler and McCallion, 1951).

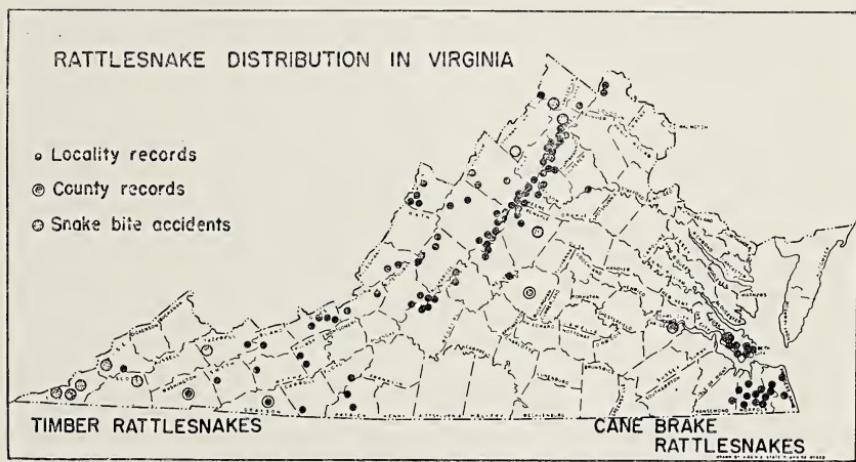
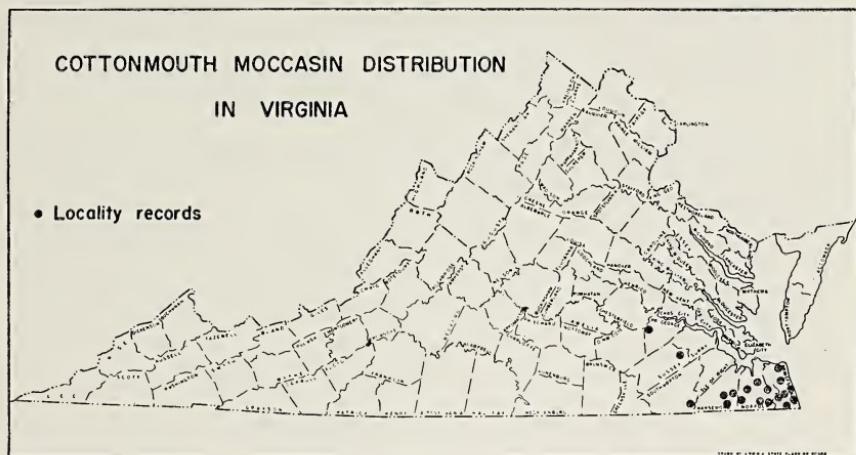
SOUTHAMPTON: 8 mi. S of Franklin (R.J.B.).

SUSSEX: Coppahauk Swamp, near Spring Hill (C.C.S.).

CANE-BRAKE RATTLESNAKES

The cane-brake rattlesnakes are confined to the Lower Austral and Coastal Section counties of southeastern Virginia, Map 4. Their range is more extensive than that of the cottonmouth moccasin Map 3) in that they range north of the James River, on the lower York-James peninsula. Although they are probably not numerous in any part of their range, they are not uncommon east of Morrison, Warwick City, where seven specimens were reported killed in a single day during a clearing operation in 1947 (V. D. McManus, personal communication, October 13, 1949). Werler and McCallion (1951) report that although this species is said to range widely in Princess Anne County, they encountered only one specimen in the course of their herpetofaunal survey of that area.

Active cane-brake rattlesnakes are reported in the field from early May through September. One hibernating specimen was discovered and killed on January 26, and another extremely sluggish specimen, presumably found in hibernation, was killed in the field on March 11 (R. J. Bartholomew, personal communication, March 11, 1953). A few late observations have been reported (November 5, and 26), but no data are available



MAP 3. (Above). The distribution of cottonmouth moccasins in Virginia.

MAP 4. (Below). The distribution of rattlesnakes in Virginia: timber rattlesnakes are found in the western and southwestern counties, and cane brake rattlesnakes are in the southeastern counties.

regarding the state of activity of these specimens. Hibernating specimens have been found alone, not in dens that are the familiar over-wintering habitats of the closely-related timber rattlesnakes.

Pope (1944) reports that the largest cane-brake rattlesnake he has examined measured 74 inches in total length. Werler and McCallion (1951) found the longest specimen reported to date from Virginia, a 72 inch specimen found in Princess Anne County. The usual specimen is

considerably smaller, more frequently ranging in total length from three to five feet.

DISTRIBUTION OF CANE-BRAKE RATTLESNAKES BY COUNTIES, MAP 4.

[24 Localities]

HAMPTON (CITY): 6 mi. NW of old Hampton boundary (O.K.G.); 4 mi. NE of Newport News (O.K.G.); near Fox's Store (O.K.G.).

PRINCE GEORGE: Hopewell (MCV-113955).

NANSEMOND: Dismal Swamp (Clarke, 1953).

NORFOLK: Algren (R.F.C.); Benefit (R.J.B.); Craddock, 1 mi. S (ART-54); Deep Creek, 3 mi. S (R.F.C.); Great Bridge (R.F.C.); Hickory, 1 mi. N (R.J.B.); Hickory, 3 mi. S (R.J.B.); Kempsville Road (R.F.C.); Lake Drummond Church (R.F.C.); Stumpy Lake (R.H.R.); Wallacetown (R.F.C.).

PRINCESS ANNE: Pungo (Werler and McCallion, 1951); Stumpy Lake (R.F.C.); Virginia Beach, 3 mi. N (R.F.C.).

WARWICK (CITY): Denbigh area (JTW-3355); Harpersville (O.K.G.); Hilton Village (O.K.G.); Morrison, 1 mi. E (V.D.M.); Morrison, 3 mi. NE (O.K.G.).

TIMBER RATTLESNAKES

The timber rattlesnakes in Virginia are widely distributed over the mountain and valley counties of the western part of the State, where they are largely confined to the Transition zone, Map 4. Their range is well separated from that of the cane-brake rattlesnakes. A local abundance of timber rattlesnakes has been reported in elevated parts of Alleghany (Hoffman, 1945), Giles (Smyth, 1949), and Bedford counties (H. S. Hedges, personal communication, April 23, 1953). Rattlesnakes have been found more common than copperheads on the higher mountain slopes. Carroll (1950) pointed out this distribution in stating that during the summer of 1948 22 timber rattlesnakes were collected in the vicinity of the Mountain Lake Biological Station, Giles County, but that only one copperhead had been taken in the same area during the season. Along Apple Orchard Creek, Bedford County, 50 rattlesnakes were killed in a camping area during the summer of 1933, 40 in 1934, and 9 in 1935. In the course of a food habits survey 141 rattlesnakes were killed in George Washington National Forest (Uhler, Cottam, and Clarke, 1939). Timber rattlesnakes are also found in all highland regions bordering on Virginia. They are found in Bell, Harlan, and Pike counties, Kentucky, and Greenbrier, Hampshire, Morgan, and Pocahontas counties, West Virginia (Gloyd, 1940).

Dens inhabited by timber rattlesnakes have been reported at elevations ranging from 1700 to 4500 feet (P. R. Burch, personal communication, August 14, 1953). The season of activity of these snakes in Virginia extends from the middle of May through September. In Shenandoah National Park the earliest date on which a timber rattlesnake has been seen is April 18, and the latest date, December 7. October and November observations are far more common than those made in April, suggesting that the time of onset of hibernation is more variable, and extends over a longer interval, than the period of emergence from over-wintering.

Smyth (1949) provides evidence to verify the solitary habits of timber rattlesnakes during the summer months in Virginia. It has been noted

that there is a marked increase in the number of rattlesnakes seen along the Blue Ridge Parkway following periods of summer drought (W. G. Lord, personal communication, March 31, 1953). Pope (1946) observes that in the spring and fall timber rattlesnakes may be seen in the open during hours of daylight, but in the summer they remain in concealment by day, and are active at night. The food of these snakes, based upon a survey of the contents of 141 stomachs, includes mice (38 per cent), rabbits (18 per cent), birds (13 percent), and shrews (5 per cent) (Uhler, Cottam, and Clarke, 1939).

DISTRIBUTION OF TIMBER RATTLESNAKES BY COUNTIES, MAP 4

[96 Localities]

ALBEMARLE: Charlottesville (UVH-206789, 66255); Brown's Gap (P.G.F.); Moorman's River (H.S.H.); Patterson Field on Skyline Drive, SNP (P.G.F.).

ALLEGHANY: Richpatch (USNM 127602); 5 mi. S of Covington (USNM 127601); 11 mi. E of Clifton Forge (UMMZ 79428); 12 mi. E of Clifton Forge (CAS 4454).

AMHERST: W slope of Mt. Pleasant (H.S.H.); Blue Ridge Parkway (W.G.L.).

AUGUSTA: Big Levels Refuge (W.P.B.); Crimora Lake Overlook, SNP (P.G.F.); McCormick Gap Overlook, SNP (P.G.F.); Mile 6, Blue Ridge Pky. (W.G.L.); Mile 8.8, Blue Ridge Pky. (W.G.L.); Mile 11, Blue Ridge Pky. (W.G.L.); Sherando Lake area (O.K.G.); Stokesville (H.G.M.J.); Staunton Dam (H.G.M.J.); West Augusta (P.S.H.).

BEDFORD: Blue Ridge Parkway (W.G.L.); Peaks of Otter (W.G.L.); Mile 88, Blue Ridge Pky. (W.G.L.).

BLAND: Freestone Valley (P.W.S.).

BOTETOURT: Apple Orchard (R.H.C.) (H.S.H.); Blue Ridge Parkway (W.G.L.); North Creek (R.H.C.) (P.W.S.).

BUCKINGHAM: County record (Dunn, 1918).

CARROLL: Mile 208, Blue Ridge Pky. (W.G.L.).

CLARKE: White Horse, 2 mi. above Berry's Ferry (Dunn, 1915-e).

CRAIG: Barbour's Creek (R.H.C.) (P.W.S.); John's Creek Mtn., 1 1-2 mi. NW of Simmonsville (CMNH 56498-99); John's Creek Mtn., fire tower near Maggie (P.R.B.).

CULPEPER: Rapidan River (USNM 84149-50).

FLOYD: Mile 169, Blue Ridge Pky. (W.G.L.).

FREDERICK: Middletown (SBMNH 9026).

GILES: Mtn. Lake Biol. Station (Smyth, 1949) (AMNH 71813, 73134, 69251) (P.M.P., P.R.B., W.L.B.) (CM 18513) (CMNH 56497); near Pearisburg (CM 21255); Little Stony Creek, Mtn. Lake Biol. Sta. (P.R.B.); Butt Mtn. (UMMZ 89870).

GRAYSON: County record (R.H.C.).

GREENE: Kinderhook, near South River (AMNH 63832); Simmons Gap, SNP (R.H.M.).

HIGHLAND: Erwin Hollow (P.J.H.); Kent Simmons Hollow (P.J.H.); Upper Campbell Hollow (P.J.H.); 5 mi. W of Monterey (P.R.B.).

LEE: Hubbard Springs (LGH 30321); Jonesville (LGH 12954); Pennington Gap (LGH 30765).

LOUDOUN: Hillsboro (USNM 14755); 3 mi. N of Round Hill (JAF-1053).

MADISON: Hughes River Gap, SNP (P.G.F.); Old Rag Mtn. (O.K.G.); Rapidan River camp, SNP (R.H.M.); near Spitler Knob Overlook, SNP (P.G.F.); near Franklin Cliffs Overlook, SNP (P.G.F.).

NELSON: Mile 29, Blue Ridge Pky. (W.G.L.); Mile 30, Blue Ridge Pky. (W.G.L.); 40 miles below Lynchburg on James River (Dunn, 1915-a).

PAGE: Elkswallow picnic grounds, SNP (P.G.F.); Elkswallow Wayside, SNP (P.G.F.); near Piney River Ranger Station, SNP (P.G.F.); Pinnacles, SNP (P.G.F.); 10 mi. N of Swift Run Gap (W.M.W.).

PATRICK: near Stuart (P.R.B.); Rocky Knob (C.H.S.).

PULASKI: 6 mi. SW of Pulaski (P.R.B.); National Forest (C.H.S.).

RAPPAHANNOCK: Mile 16, Skyline Drive, SNP (P.G.F.); near Pinnacles Overlook, SNP (P.G.F.); Piney River, SNP (R.H.M.); Rangeview area, SNP (P.G.F.); Rattlesnake Point, SNP (P.G.F.); Tunnel Overlook, SNP (P.G.F.); County record (USNM 19920).

ROCKBRIDGE: Arnolds Valley (P.W.S.); Goshen Pass below Laurel Run (H.S.H.).

ROCKINGHAM: Block Hollow, Geo. Wash. Nat. Forest (P.J.H.); Briery Branch (H.G. M.J.); Brown Mtn. Overlook, SNP (P.G.F.); Fulks Run, N of Harrisonburg (H.S.H.); near Big Run fire tower, SNP (P.G.F.); near Rocky Top Overlook, SNP (P.G.F.); 9 mi. S of Elkton (W.M.W.); 1 mi. N of Simmons Gap, SNP (P.G.F.); 5 mi. N of Swift Run Gap, SNP (W.M.W.).

SCOTT: Dungannon (Thomas, 1953).

SHENANDOAH: Newmarket (RMH 97074).

SMYTH: Hurricane Branch, Iron Mtn. (P.W.S.).

TAZEWELL: Big Creek, near Richlands (CVCH 11495); Freestone Valley (P.W.S.).

WARREN: Compton Gap, SNP (R.H.M.); Front Royal (UVH 228060); Lands Run Gap, SNP (P.G.F.).

WASHINGTON: County record (R.H.C.).

WISE: Stonega (LGH 25490); High Knob (P.W.S.).

WYTHE: Iron Mtn. (P.W.S.).

DISTRIBUTION SUMMARY

The distribution of poisonous snakes in Virginia is important to both physicians and laymen. The interest of the physician stems from the fact that copperheads inflict relatively mild cases of venom poisoning, and rattlesnakes generally cause grave cases. If the physician practices in an area inhabited only by copperheads, he can anticipate, with very high probability, a favorable outcome in the case of unidentified snake-bite. The copperhead is the only poisonous snake found in 47 of the 98 Virginia counties, as follows:

ACCOMAC	FLUVANNA	MIDDLESEX
AMELIA	GLOUCESTER	NEW KENT
APPOMATTOX	GOOCHLAND	NORTHAMPTON
ARLINGTON	HALIFAX	NORTHUMBERLAND
BRUNSWICK	HANOVER	NOTTOWAY
BUCKINGHAM	HENRICO	ORANGE
CAMPBELL	HENRY	PITTSYLVANIA
CAROLINE	JAMES CITY	POWHATAN
CHARLES CITY	KING AND QUEEN	PRINCE EDWARD
CHARLOTTE	KING GEORGE	PRINCE WILLIAM
CHESTERFIELD	KING WILLIAM	RICHMOND
CULPEPER	LANCASTER	SPOTSYLVANIA
CUMBERLAND	LOUISA	STAFFORD
DINWIDDIE	LUNENBURG	WESTMORELAND
ESSEX	MATHEWS	YORK
FAIRFAX	MECKLENBURG	

Map 5 shows timber rattlesnakes present in Buckingham and the east border of Nelson counties, based upon records more than 35 years old. The present survey has not established that rattlesnakes have persisted in these regions. The Culpeper specimen is fairly recent, non-specific as to locality, and probably originated in the southwestern highlands of the county although other distribution data suggest that rattlesnakes are infrequent in that area today.

In 11 counties the copperhead is widely distributed, and the timber rattlesnake is restricted therein to the vicinity of the foothills and mountains along the western borders. These counties are all along the margin of the merging Piedmont and Blue Ridge, and are as follows:

ALBEMARLE	FRANKLIN	NELSON
AMHERST	GREENE	PATRICK
BEDFORD	LOUDOUN	RAPPAHANNOCK
FAUQUIER	MADISON	

In 31 counties both copperheads and timber rattlesnakes are prevalent.

The copperheads predominate in the valleys and lower slopes, and the rattlesnakes in the higher slopes. The counties are as follows:

ALLEGHANY	FREDERICK	RUSSELL
AUGUSTA	GILES	SCOTT
BATH	GRAYSON	SHEPHERD
BLAND	HIGHLAND	SMYTH
BOTETOURT	LEE'	TAZEWELL
BUCHANAN	MONTGOMERY	WARREN
CARROLL	PAGE	WASHINGTON
CLARKE	PULASKI	WISE
CRAIG	ROANOKE	WYTHE
DICKENSON	ROCKBRIDGE	
FLOYD	ROCKINGHAM	

The cane-brake rattlesnakes, cottonmouths, and copperheads are found in 9 counties as follows:

GREENSVILLE	NORFOLK	SOUTHAMPTON
ISLE OF WIGHT	PRINCE GEORGE	SURRY
NANSEMOND	PRINCESS ANNE	SUSSEX

The only poisonous snakes on the eastern end of the York-James peninsula (Hampton, Newport News, and Warwick) are cane-brake rattlesnakes.

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Observations have been contributed by the 27 naturalists and herpetologists listed earlier. These workers represented the following institutions: Blue Ridge Parkway, Bridgewater College, George Washington National Forest, Hollins College, Jefferson National Forest, Michigan State College, Philadelphia Zoological Society, Radford College, Shenandoah National Park, University of Illinois, University of Virginia, Virginia Commission of Game and Inland Fisheries, Virginia Division of Forestry, and Virginia Fisheries Laboratory.

Medical records on cases of snake venenation in Virginia were made available by the 19 Virginia hospitals and clinics listed earlier.

Without the generous cooperation of all of these persons and institutions this survey would have been impossible. The author acknowledges his gratitude to all of the above.

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A New Branchiobdellid of the Genus *Cambarincola* (Oligochaeta, Branchiob- dellidae) from Virginia¹

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The branchiobdellid worms, among several other groups of animals, are adapted to a life on the exoskeleton of holarctic freshwater crayfishes. Available data indicate that this is an obligate relationship on the part of the worms in spite of the fact that there is evidence that most members of the latter are not parasitic on the host. That the relationship is not of recent origin seems probable in view of the fact that certain species are restricted to certain anatomical regions of the crayfish. Some are found on the chelipeds (species of *Xironogitan* and *Xironodrilus*), others around the bases of the pleopods, while a few are restricted to the branchial chambers. The new species described below is found in the latter.

The first branchiobdellid recognized was a gill inhabiting form, *Branchiobdella astaci*, which was described in 1823 by Odier. Subsequent reference to the presence of these worms in the gill chambers of crayfishes are meager but Gruber (1883) reported *B. hexadonta*, an European species, from the branchial cavity of its host, and Yamaguchi (1934: 216) found *Stephanodrilus ezoensis* and *S. megalodontatus* only in the gill chambers of the Japanese crayfishes while *S. inukaii* and *S. nipponicus* were found in the gill chambers as well as on the outer surfaces of the host. *Cambarincola branchiophila*, sp. nov. is the second known North American species which is known to be restricted to the branchial chambers of the crayfish; of the other North American species only *Bdellodrilus illuminatus* (Moore 1894) is confined to this microhabitat.

Cambarincola branchiophila, sp. nov.

(Plate I, figs. 1 to 5)

Diagnosis.—Gill inhabiting branchiobdellid; lips entire, set off by a sulcus from the remainder of the head; dental formula 5/5, with lateralmost teeth longer than teeth between them and median tooth; major annulations not raised; proximal part of the spermatic vesicle bifurcate; accessory sperm tube shorter than spermatic vesicle but relatively large in diameter; spermatheca elongate, spatulate, subequal in diameter throughout its length; medium sized, relatively thick worms, superficially resembling *Bdellodrilus illuminatus* in external appearance.

Description.—Eight specimens, mounted entire, of this species have been studied. The following measurements are those of the type specimen which approaches the maximum in size. Total length: 3.37 mm.

¹ From a thesis submitted to the Graduate Faculty of the University of Virginia in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

Diameter, segment I: 0.38 mm. Diameter, segment VI: 0.70 mm. Diameter, sucker: 0.41 mm. Length, head: 0.33 mm. Diameter, head: 0.40 mm.

The general appearance of this worm, when examined with the low power of the dissecting microscope, is quite unlike most members of the genus. In the contracted state, however, it resembles *Bdellodrilus illuminatus*. This resemblance is seen in the relatively great diameter of the sexual segments in comparison to that of the head and sucker — a condition apparently the result of the less heavily muscular character of the anterior and posterior regions — and in the strongly arched form of the body when contracted. This apparent similarity between these worms is superficial for upon careful examination the cambarincolid characteristics of *Cambarincola branchiophila* become evident.

The lips are entire, without indentations, lobes, or tentacles, and are set off from the remainder of the head by a sulcus. The head is further subdivided by another encircling groove, which with the one that sets off the lips, divides the head into three parts (fig. 1). This is in contrast with the condition in *Bdellodrilus illuminatus* where the head is divided into four parts (Moore 1895: 499).

The body outline is, in general, smooth; the major annulations are not significantly raised above the minor ones except at the anterior and posterior ends of contracted animals where they are slightly elevated. The characteristics of the gut, the location of the single nephridiopore, and the location of the anus are similar to those of the other members of the genus.

Although in lateral aspect the jaws appear to be similar to those of *Cambarincola philadelphica*, a critical study of them reveals their distinctive character. The dental formula is 5/5, the dorsal and ventral jaws being similar. The lateral teeth are subequal in length to the median one, while the teeth lying between the lateral teeth and the median one are shorter (figs. 4 and 5).

The reproductive system resembles somewhat that of *C. philadelphica*, but the following differences may be noted. The proximal portion of the spermatic vesicle which receives the vasa deferentia is rather deeply indented or bifurcated between the points of entry of the vasa deferentia. The vasa deferentia are large for the genus, being 22.8 microns in diameter in the type specimen, whereas those of *C. philadelphica* average only 13.1 microns in diameter with 14.2 microns the maximum recorded (Holt, 1949: 552). The spermatic vesicle lies obliquely along the left side of the coelom in the type specimen and gives off the accessory sperm tube and the ejaculatory duct from its anterodorsal border. The size of the accessory sperm tube, 52 microns in diameter in the type specimen, is its most distinctive characteristic; in *C. philadelphica* this diameter averages only 28.2 microns (Holt, 1949: 552-553). A proportionally large bulb terminates the blind end of the accessory sperm tube in *C. branchiophila*. The spermatic vesicle measures 99.8 microns in diameter just distad to the bifurcation mentioned above; in contrast, the spermatic vesicle of *C. philadelphica* averages 82.5 microns in diameter.

The ejaculatory duct is relatively larger in *C. branchiophila* than in *C. philadelphica*. The bursa, while as large, relatively, as in other species studied (Holt, in ms.), appears to have thinner and less muscular walls, particularly in the part which ensheathes the penis, but this is a point that needs to be confined by the study of sectioned material.

The spermatheca (fig. 3) is almost straight, running vertically along the left side of the gut in the type specimen. The spermathecal duct is rather short and the bulbular portion is of not much greater diameter than the duct. The whole is spatulate in outline.

Type locality.—Sinking Creek, Giles County, Virginia.

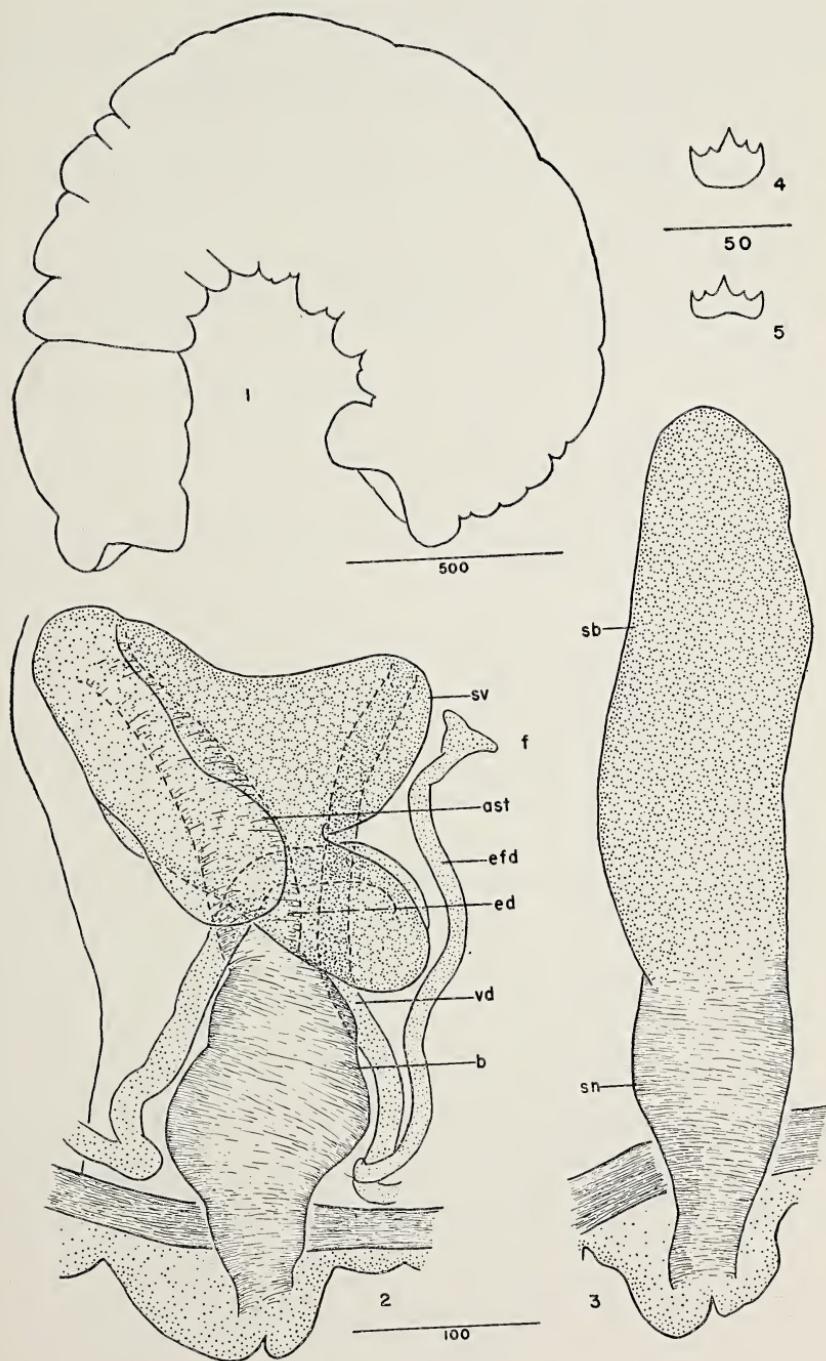
Hosts.—*Cambarus bartonii bartonii* Fab. and *Cambarus sciotensis* Rhoades.

Disposition of types.—The holotype is deposited in the United States National Museum, Cat. No. 25855. One paratype is in the collection of Horton H. Hobbs, Jr., University of Virginia, and the remaining paratypes are in the author's collection.

Specimens examined and locality record.—Eight specimens mounted entire from Sinking Creek, Giles County, Virginia, at the point where crossed by State Highway 700. Collectors: F. D. Kiser, Cornelia Tuten, and P. C. Holt.

Relationships.—*Cambarincola branchiophila* belongs to Goodnight's subgenus *Cambarincola*, but a more exhaustive study must be made of the numerous described and undescribed species of the genus before the validity of Goodnight's subgeneric groupings is confirmed. The dental structure of *C. branchiophila* is, as far as is known, peculiar to this species, approaching in the almost subequal length of the lateral and the median teeth the condition in *C. vitrea*, where the teeth of the upper jaw are subequal (Ellis, 1919: 258), but differing in the dental formula and structure of the lower jaw as well as in the shortness of the next to the most lateral teeth. The male reproductive system, while clearly cambarincolid in character, is not markedly similar to that of any previously described species and resembles most closely that of a new species in the author's collection (Holt, in ms.). It differs noticeably from previously described forms in the greater diameter of the accessory sperm tube in relation to that of the spermatic vesicle and in the bifurcate character of the latter.

Remarks.—This species' adaptations to a habitat not shared, so far as is known, by any of its congeners are worthy of note. The more obvious of these adaptations are the reduction of the body wall musculature mentioned above and an apparent increase in the size and number of the epidermal glands found in all branchiobdellids. Histological studies are needed to confirm the latter. These features—the reduced musculature and the larger epidermal glands—are shared with *Bdelloidrilus illuminatus*, and in some unknown fashion would appear to be correlated with the conditions of life in the gill chambers of the host. It is the author's belief that a study of the adaptations of the branchiobdellids to anatomical regions of their hosts should furnish much material for many pleasant hours of speculation by those interested in problems of "ecological speciation" and convergent, as well as divergent, evolution.



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EXPLANATION OF FIGURES

1. *Cambarincola branchiophila* in lateral view.
2. Male reproductive system of *C. branchiophila*.
3. Spermatheca of *C. branchiophila*.
4. Upper jaw of *C. branchiophila*.
5. Lower jaw of *C. branchiophila*.

Legend.—ast, accessory sperm tube; b, bursa; ed, ejaculatory duct; efd, efferent duct; sb, bulb of spermatheca; sn, spermathecal duct; sv, spermatic vesicle; vd, vas deferens.

Changes In The Physiography Of Oyster Bars In The James River, Virginia¹

NELSON MARSHALL

The Oceanographic Institute Florida State University, Tallahassee, Florida

The intent of the Baylor Survey of 1892 was to define the naturally-producing oyster grounds in Virginia waters and to set them aside for public use. Actually, some natural ground was omitted and some barren ground was included within the bounds of the Survey; however, it stands as a definition of public grounds from which any citizen of the State may, for a small fee, obtain a license to take oysters. Only hand tongs are permitted in this public fishery.

These oyster bars within the Baylor Survey are about twice as extensive as the ground outside leased to private planters but they yield only about one-third as many oysters of market size (Marshall, 1951). On the other hand, certain of these public grounds provide the seed or small oysters that are transplanted to private grounds and are essential to the success of leased bottoms which are seldom self-sustaining. Based on this relationship an extensive area in the lower James River (Figure I) noted for its capacity to produce great numbers of small oysters, has been established by law as a seed area. This area is not subject to the usual regulation that oysters must remain on public grounds till they grow to marketable size. Tongers harvest and sell to private planters from one to two million bushels of seed oysters from this James River area annually. Actually each such bushel is a mixture of small seed oysters, the old shell to which the seed have attached, and a small quantity of oysters of marketable size.

The removal of this mixture of live oysters and shell might reduce critically the amount of cultch available for the setting of larvae. This might also cause decline and other changes in the surface of the bars, thus modifying the hydrodynamics of the region and otherwise disturbing ecological conditions. The widely varied speculations concerning such effects make it especially imperative to search for data on this subject. A step that can be taken toward this end is to compare soundings on early hydrographic surveys with those taken more recently and thus to observe some of the physiographic changes that have actually occurred. The first complete depth surveys of the portion of the lower James River in question are those made by the U. S. Coast and Geodetic Survey in 1854-55. Additional comprehensive surveys were conducted by the Survey in 1871-73 and 1943-48. All such soundings are plotted on what are known as hydrographic surveys which, of course, provide the primary reference data for drafting navigation charts, etc.

¹ Contribution from the Virginia Fisheries Laboratory, No. 52 Contribution No. 17, Oceanographic Institute, Florida State University.

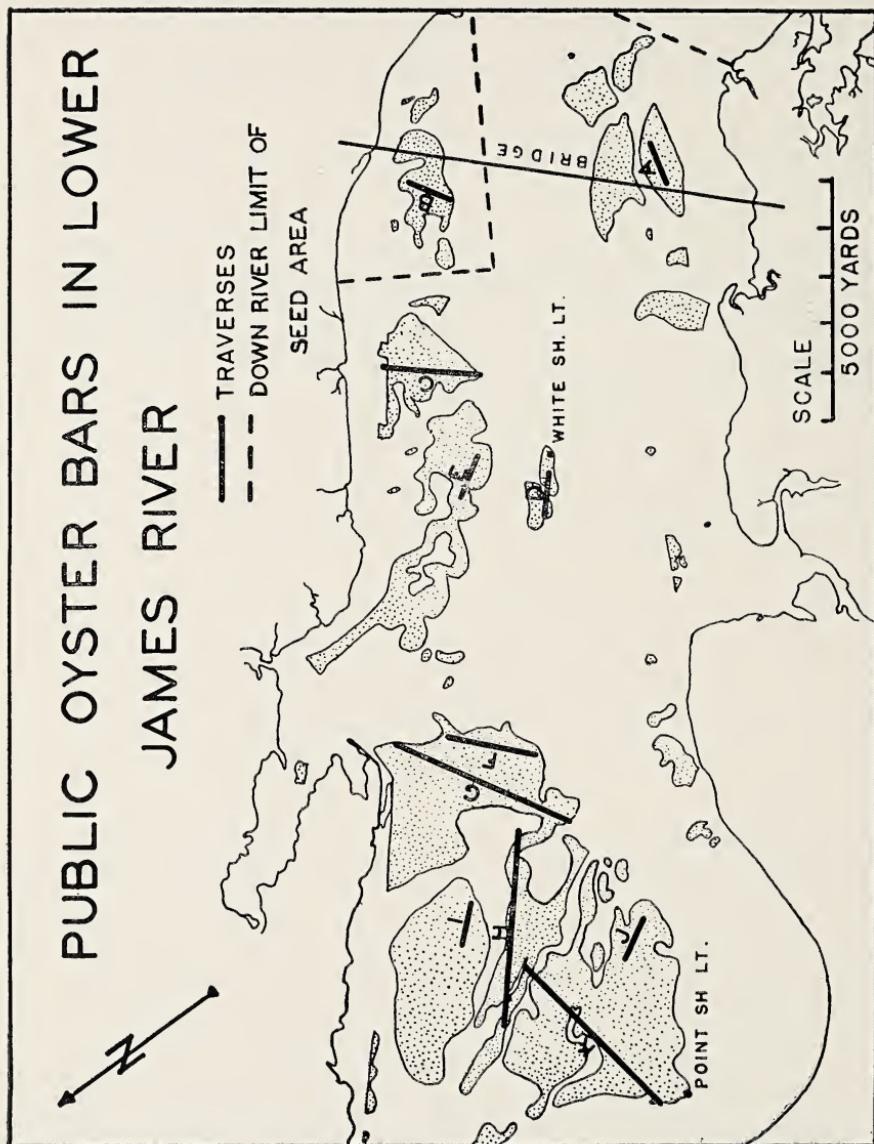


FIGURE I. Public Oyster Bars in Lower James River. The location and length of these traverses, also the names of the bars covered, are indicated in Table I.

METHODS

From Moore's (1910) maps of the oyster grounds in the area, as his party observed them shortly before his publication, traverses were selected across representative bars. Each such traverse (Figure I and Table I²) is a straight line, crossing, for at least 75 per cent of its length, grounds which Moore designated as supporting a dense growth of oysters. An exception is the straight line across Brown Shoal which, though not covering such a high percentage of dense growth, was studied to represent bars that were formerly exposed at low water.

These traverses were plotted on the hydrographic survey of each period mentioned above, and using the shortest interval practical on the less intensive older survey, the depths were read every 100 yards. Thus at every hundred yards a point was established at which depths could be compared on successive surveys. As reported by the U. S. Coast and Geodetic Survey (correspondence from the Acting Director, 1949 and 1952) there has been a 0.6 foot rise in sea level in the region between 1855 and the late 1940s. To allow for this in the present study concerned with bottom changes, a one-half foot correction factor was used when comparing soundings of the 1940s with those of earlier years.

The points on these traverses that lie over slopes and channels are not well suited for this study. Oystering is not limited to the crests of the bars, yet points over the slopes often miss oyster bottom; depths at such points are likely to be altered primarily by hydrographic conditions, perhaps with little relation to oystering and oyster growth; and errors in surveying and draftsmanship are exaggerated in contrasts over sloping surfaces. For these reasons, only those points over relatively level stretches of the bottom, well up on the bars, were compared.

RESULTS AND DISCUSSIONS³

At 121 of the points compared the bottom was more elevated in the 1850s than it was in the 1940s, whereas the reverse was true at 38 points. An analysis of the depth differences at these points for the entire ninety-year period is as follows:

Number of points compared	= 173
Mean of depth differences	= -1.1 ft.
Standard deviation of differences	= 1.9 ft.
Standard error of differences	= 0.14 ft.
t value	= 7.9
95% fiducial limits of differences	= -0.82 to -1.38 ft.

² Point of Shoals Light and White Shoals Light, used as reference points in defining the traverses, are not operating but still stand. In some cases it was obvious that a traverse drafted on Moore's maps of the area crossed slightly different grounds than when plotted on the hydrographic surveys of the U. S. Coast and Geodetic Survey. It was assumed that this was due chiefly to errors in Moore's maps. This does not, of course, affect the accuracy of comparisons between hydrographic surveys.

³ Table II presents a summary of the data giving means of depths and means of differences at comparison points. The complete data are on file at the Virginia Fisheries Laboratory and are scheduled to appear in the *Proceedings of the National Shellfisheries Association* for 1953 (near print).

An analysis of the depth differences for the first 17-18 years is as follows:

Number of points compared	= 173
Mean of depth differences	= -0.3 ft.
Standard deviation of differences	= 2.2 ft.
Standard error of differences	= 0.17 ft.
t value	= 1.8
95% fiducial limits of differences	= +0.04 to -0.64 ft.

As another check, all the depths at the comparison points were lumped for each of the three periods. These three samples were subjected to an analysis to see if they might have been drawn from a single population. This analysis of variance gives an F value of 5.90, indicating a greater than 99% probability that there is a real difference between the groups.

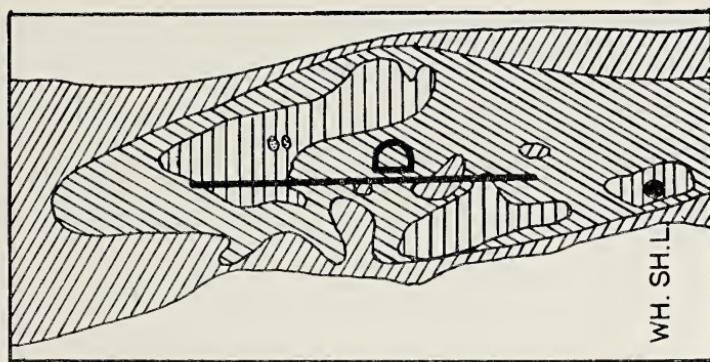
These analyses support certain generalizations, applicable to the extent these data represent the history of the oyster bars. Over the ninety-year span there has been a mean lowering of about one foot from the crests of the bars, this being in addition to the depth change due to a rise in sea level. This figure is statistically significant, far better than the 1% probability level, and lies within relatively narrow fiducial limits. The analysis for the first eighteen years leaves greater doubts as to the validity of the calculated depth change of 0.3 feet. The low t value indicates that the mean difference is not highly significant, and the fiducial limits indicate the change could have been a slight increase rather than a loss from the surface of the bars.

Quite noticeable in survey comparisons is the almost complete disappearance of emergent or intertidal oyster shoals since the 1870s. Though the surveys do not always indicate it, it is probable that the typically elongate, exposed areas in the middle of the oyster grounds are intertidal oyster reefs. Ignoring the shoals adjacent to and thus essentially a part of the shore, approximately 12,000 yards of intertidal reefs were noted from the 1854-55 surveys, 17,000 yards in the 1871-73 surveys, and less than 100 yards in recent surveys. On the original surveys there are so many indications of more thorough work in the 1870s than in the 1850s that the added reef measurements of the second period seem to result from more critical surveying. On the other hand, the difference indicated between the 1870s and the 1940s seems real, as would be expected with a one-foot mean loss from the surfaces of the oyster bars plus the half-foot rise in sea level.

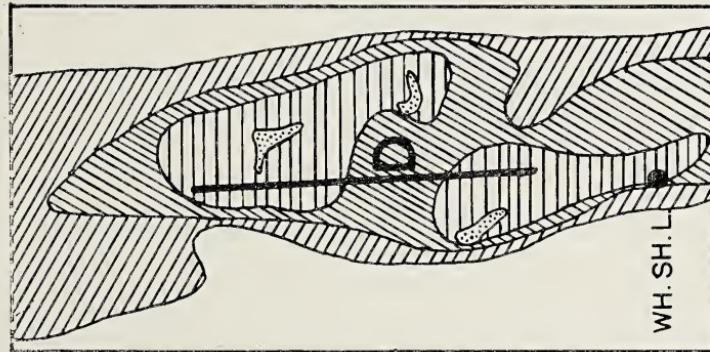
DISCUSSION

The depth comparisons may be discussed under two interdependent headings — the net loss of surface over the ninety-year period, and the variation from point to point. The variation indicates that changes in the bars may be quite different even within relatively short distances. This is also apparent from depth contours, as illustrated in Figure II of the White Shoals area. That the changes should be so varied seems to

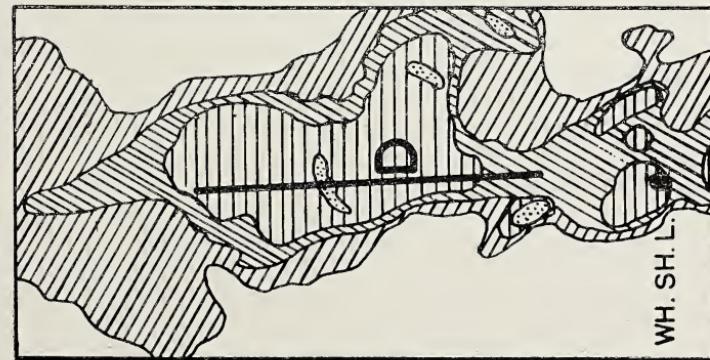
1943-48



1871-72



1854-55



ABOVE
M. L. W.
— 6 FT.
— 12 FT.
— 18 FT.

ABOVE
M. L. W.
— 6 FT.
— 12 FT.
— 18 FT.

FIGURE II. Depth Contours in the Vicinity of White Shoals Light. Transect line D, 1000 yards, is drawn in to show location and scale.

stress the importance of natural environmental factors, cutting, building, and depositing sediments to mold the shape of the grounds. Thus the bars are quite dynamic, everchanging in form. Though the physical and biological forces involved must be set aside in this discussion as a complex not thoroughly analyzed, it is important to recognize that final effects involve an interaction between such natural forces and the fishery influences. Such interactions are similar to those encountered in dealing with the many fishery populations that obviously vary in response to environmental forces.

Before considering the possible role of the fishery in the net decline of the bars, two forces should be mentioned that constantly tend to lessen the depth. (1) Whatever oysters are on the bars continuously add to their shells and thus to the bottom development. (2) This is an area of salting out of matter in suspension, associated with a marked downstream increase in the salinity and clarity of the water (see Chesapeake Bay Institute Data Report, No. 7, 1952, for tabulations of salinity and light transmission). Brown, Seavy, and Rittenhouse (1939) reported large scale filling due to sedimentation in the York River and Gottschalk (1945) reported the same for the upper Chesapeake Bay and its tributaries. If the James is at all comparable, it must be assumed that there has been a great deal of filling in the seed area. It may be, however, that the scouring and cleansing action of live oysters has kept sedimentation at a minimum over the bars.

To consider the effect of oystering in the over-all decline in the surfaces of the bars it is necessary to estimate the magnitude of shell removal by the fishery. Catch statistics applicable to the seed area, which coincides with the region of these depth comparisons except that the latter included Brown Shoal (Traverse B B¹), are the only records from which we might estimate shell removal rates. The harvest of seed oysters in Virginia is given in various U. S. Fish and Wildlife Service (formerly U. S. Bureau of Fisheries) reports and is presented in what appear to be comparable summaries for the 1920-21 and the 1924-25 seasons and the years 1929 through 1944. The average annual seed harvest in these years in terms of U. S. standard bushels was 1,675,000. Since only seed oysters are harvested from the James River seed area and since the recorded Virginia seed harvest is almost entirely that of the James, it seems reasonable to use a rounded figure of 1,500,000 bushels to represent the annual removal during the period covered by the data.

The use of the bars in the lower James River has changed through the years, but as Wharton's (1948) historical review suggests, oystering in the state was probably as intensive in the 1850s as it is today and the James River has always been the center of this fishery. Thus the estimate of 1,500,000 bushels a year, taken from the region now defined as a seed area, may be used for the entire period since 1854. Of this harvest the actual volume in seed is small for the small oysters are generally attached to empty shells which may comprise about two-thirds of the total or 1,000,000 bushels annually. On the other hand, removal of empty shell from the surface of bars was undoubtedly less extreme in former years when

the region was used more for market oysters. For an approximation of the average annual removal of empty shell incidental to the removal of live oysters from this area since the 1850s, a figure of 700,000 bushels will be used.

Moore (1910) found about 3200 acres of dense growth on the bars of the present seed area. If we assume that two-thirds of the estimated shell removal comes from such areas this would amount to a layer 0.05 inches deep taken from this area annually. At such a rate a little less than 5 inches of shell would have been removed in the ninety-year period, whereas the net decline at the points compared was about 1 foot.

These removal estimates, being extremely crude, cannot be used as a basis for critical interpretations. On the other hand, if one were to make allowance for factors tending to build the bars and then were to estimate the removal of shell involved in the net loss of a foot, the figure would greatly exceed the above estimates from catch records. This raises many questions. The catch records may fall far short of the actual harvest, or the actual lowering of the bars may be less than indicated by the data presented here. The removal of shell may initiate depletion processes which exceed the amounts tonged from the bars. Possibly there has been some settling of the river bottom in general, producing a lowering of oyster bars.

SUMMARY

This study compares original U. S. Coast and Geodetic Survey depth observations over the productive oyster bars of the lower James River for the period 1854-55 through 1943-48. There was considerable variation in the physiographic changes in the surface of the oyster grounds during that period; however, at most points depth comparisons indicated decline, and the net effect was a mean loss of about a foot in the elevation of the bars.

The variations in depth comparisons and changes in the courses of depth contours suggest that oyster bars are quite dynamic, changing form in response to environmental factors. The physiographic history of these bars is probably the result of both natural and fishery influences just as fishery populations have complex histories of interwoven fishing and environmental effects.

ACKNOWLEDGMENTS

Some of the expense and support for this study has been borne by the Virginia Fisheries Laboratory and the Chesapeake Bay Institute. My former associates at the Virginia Laboratory, Dr. Jay D. Andrews and Dr. J. L. McHugh, have been especially helpful in reviewing this manuscript.

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TABLE I. Location of Traverses of Oyster Bars in the Lower James River, Virginia

GALLEY SIXTEEN					(16)
	Distance	Direction	Reference	Traverse	Description
A	5985 yds.	30.2° EofS	of Wh. Shoal Lt.	1000 yds. across	
A ¹	6795 yds.	35.6° EofS	of Wh. Shoal Lt.	Fishing Pt. Rks.	
B	6350 yds.	81.9° EofS	of Wh. Shoal Lt.	1000 yds. across	
B ¹	5539 yds.	76.0° EofS	of Wh. Shoal Lt.	Brown Shoal	
C	2168 yds.	87.9° EofN	of Wh. Shoal Lt.	2000 yds. across	
C ¹	3818 yds.	65.3° EofN	of Wh. Shoal Lt.	Kettle Hole Rk.	
D	1328 yds.	45.6° WofN	of Wh. Shoal Lt.	1000 yds. across	
D ¹	315 yds.	42.5° WofN	of Wh. Shoal Lt.	White Shoal	
E	2025 yds.	12.3° EofN	of Wh. Shoal Lt.	1000 yds. across	
E ¹	1455 yds.	40.2° EofN	of Wh. Shoal Lt.	Thomas Pt. Rk.	
F	9030 yds.	86.4° EofS	of Pt. Shoal Lt.	2000 yds. across	
F ¹	7680 yds.	75.9° EofS	of Pt. Shoal Lt.	Wreck Shoal	
G	6210 yds.	75.7° EofS	of Pt. Shoal Lt.	4000 yds. across	
G ¹	7585 yds.	87.8° EofN	of Pt. Shoal Lt.	Wreck Shoal	
H	4058 yds.	58.9° EofN	of Pt. Shoal Lt.	4000 yds. across	
H ¹	6488 yds.	84.3° EofS	of Pt. Shoal Lt.	Mulberry Swash Rk.	
I	5640 yds.	70.8° EofN	of Pt. Shoal Lt.	1000 yds. across	
I ¹	6010 yds.	80.2° EofN	of Pt. Shoal Lt.	Marshy Rock	
J	3188 yds.	78.7° EofS	of Pt. Shoal Lt.	1000 yds. across	
J ¹	3855 yds.	66.4° EofS	of Pt. Shoal Lt.	Pt. of Shoals Rk.	
K	615 yds.	25.8° EofN	of Pt. Shoal Lt.	4000 yds. across	
K ¹	4380 yds.	77.2° EofN	of Pt. Shoal Lt.	Long Shoal and Swash Rock	

TABLE II. Summary of depth comparisons at 100-yard intervals over oyster bars in the James River, Virginia. Depths from U. S. Coast and Geodetic Survey hydrographic surveys.

Trav.	N	Means of depths in ft. from readings at comparison pts.		1854-55 minus 1871-73	Means of differences at comp. pts. 1943-48 + $\frac{1}{2}$ *	
		1854-55	1871-73		1854-55	1854-55 minus
AA ¹	11	5.0	5.7	6.0	-0.59	-0.41
BB ¹	9	0.7	3.6	5.5	-3.00	-4.39
CC ¹	17	7.7	7.2	7.9	+0.46	+0.29
DD ¹	8	4.6	3.9	6.6	+0.75	-1.44
EE ¹	9	9.6	9.6	10.7	0.00	-0.61
FF ¹	18	5.6	7.9	8.5	-2.25	-2.54
GG ¹	36	6.1	6.4	7.6	-0.31	-1.02
HH ¹	19	9.8	9.6	10.4	+0.29	0.00
II ¹	11	9.8	10.5	10.8	-0.73	-0.48
JJ ¹	9	4.7	5.6	6.8	-0.94	-1.72
KK ¹	26	5.0	4.0	6.1	+1.03	-0.62

* Added to offset differences resulting from a half-foot rise in sea level.

News and Notes

AGRICULTURAL SCIENCE SECTION

Dr. K. W. King and Dr. R. W. Engel of the Virginia Agricultural Experiment Station attended the meetings of the Federated Society of Experimental Biologists held at Atlantic City during the week of April 11-15. A paper, entitled "Relation of Diet to Toxicity of Chlorinated Naphthalene in Rats" by Engel, Linkous, and Bell, was presented before the American Institute of Nutrition scientific sessions by Dr. Engel. At the annual business meeting Dr. Engel was elected Secretary of the American Institute of Nutrition for a three-year term.

A new course will be offered for the first time in the fall quarter by the Department of Dairy Husbandry in Public Relations in Dairying. The course deals with local, state, and national dairy organizations; duties of representatives for dairy and service organizations, and the relationship to other groups and individuals, as well as a discussion on promotional, supervisory, and educational problems. It is a senior course and will be taught by Professor P. M. Reaves.

The Department of Dairy Husbandry will be well represented on the program of the American Dairy Science Association's annual meeting to be held at Pennsylvania State University on June 21-24. Three members, Dr. G. C. Graf, Dr. W. A. Hardison, and Professor N. R. Thompson, will present papers. Professor R. G. Connelly and Dr. K. A. Huston will appear on a panel discussion. The Department will also have an exhibit at the meetings.

Mr. Thomas G. Brown of Halifax County has recently accepted the position of assistant soil technologist at the Virginia Truck Experiment Station at Norfolk. Mr. Brown received his B.S. degree in Agronomy at the University of Tennessee in 1950, after having served three years in the Naval Air Corps during World War II. Mr. Rhody B. Hall, former assistant soil technologist, is now an agronomist with the American Agricultural Chemical Company.

Dr. Glenn H. Robinson, a member of the Correlation Staff of the Soil Survey Division of the Soil Conservation Service, U. S. D. A., was assigned to Blacksburg, Virginia as headquarters on April 1, 1954.

Dr. Robinson will be responsible for the correlation of soils mapped in the cooperative Experiment Station and U. S. D. A. Survey in Virginia, North Carolina, and South Carolina. He received his Bachelor's degree from Purdue University, the Ph.D. degree from the University of Wisconsin, and has had a very wide experience in soil classification work both in the United States and abroad.

The first Virginia Polytechnic Institute Agricultural Exposition was held at Blacksburg on May 14 and 15. This was a new endeavor which was sponsored by the various curricula clubs on the campus.

Sidney D. Rogers, Winchester, took top honors in the Little International

and E. A. Drinkwater, Bayard, top honors in the Dairy Club show to feature the 1954 Agricultural Exposition May 14-15.

Don Paarlberg, assistant to the U. S. Secretary of Agriculture, was convocation speaker May 14, and he discussed the Eisenhower farm program, describing it as a compromise between the extremes of government control and full market freedom. Edward A. Wayne, First Vice-President of the Federal Reserve Bank of Richmond, spoke at the Exposition banquet May 15.

Mr. Charles B. Wood has been appointed Research Instructor of Fruit and Vegetable Processing in the Department of Horticulture at Virginia Polytechnic Institute. Mr. Wood is a native of Virginia who received his B.S. degree from Virginia Polytechnic Institute in June, 1954.

Mr. George Goddard has been appointed Research Instructor of Horticulture at Virginia Polytechnic Institute. He will assist in the research and college work conducted at the greenhouses. Mr. Goddard received his B.S. degree from the University of Massachusetts in June, 1954.

Mr. Donald B. Dunlap has been appointed Research Instructor of Horticulture at Virginia Polytechnic Institute. He will assist in the fruit breeding research program. Mr. Dunlap received his B.S. degree from Clemson Agricultural College in June, 1954.—WESLEY P. JUDKINS.

ENGINEERING SECTION

Professor Dan Fletta of Virginia Polytechnic Institute has been asked to serve as a recorder for a discussion group at the National Conference on Higher Education in Chicago. On March 8-10 he attended the Allerton Conference on Solid State Science, sponsored by the National Science Foundation in conjunction with the University of Illinois and Carnegie Institute of Technology.

Members of the Engineering Section attending the annual meeting of the Virginia Society of Professional Engineers at Virginia Beach May 21 and 22 included Professors R. W. Truitt and Dan Pletta of Virginia Polytechnic Institute.

Professors R. W. Truitt and F. W. Martin of Virginia Polytechnic Institute have published a paper in the Journal of Aeronautical Sciences entitled "Effect of After-body Configuration on the Pressure Distribution on Wedges."

Professor N. F. Murphy escorted a number of graduate and senior chemical engineering students from Virginia Polytechnic Institute to the Corrosion Testing Station of the International Nickel Company at Wrightsville Beach, North Carolina on April 26 and 27. Professor Murphy also attended the annual meeting of the Electrochemical Society in Chicago, May 3 and 4.

Professor R. M. Hubbard escorted a group of chemical engineering students from the University of Virginia to the annual meeting of the Mid-Atlantic Regional Group of Student Chapters of the American Institute of Chemical Engineers at Morgantown, West Virginia April 9 to 11, and then accompanied the students on a visit to the Monsanto Chemical Com-

pany plant at Nitro and the Carbide and Carbon Chemical Company Research Laboratory at South Charleston, West Virginia.—ROBERT M. HUBBARD.

SECTION OF GEOLOGY

Dr. Wayne E. Moore is experimenting with the culture of live Foraminifera in the paleontological laboratory at Virginia Polytechnic Institute. He has maintained a live culture of miliolid Foraminifera for more than three months, and has studied the feeding habits, methods and rates of locomotion, and salinity tolerance of these one-celled animals. The results of these observations will be useful in ecological studies of the Foraminifera.

The new sedimentation laboratory of the Geology Department at Virginia Polytechnic Institute is nearing completion. The major item of new equipment for the laboratory is a stream table for the study of stream and coastal erosion and sedimentation phenomena. The new stream table consists of a 12-foot trough, which can be tilted and which empties into a 6-foot long tank of standing water. The trough and tank are five feet wide and 18 inches deep. The tank is fitted with glass sides so that depositional structures formed in standing water may be observed. The level of the water in the tank can be changed by 2-inch intervals. The laboratory will be available for research and instructional use by the fall quarter of this year.

John A. Wood, Jr. received this year's Holden Prize. The prize, a Brunton compass, is awarded annually to the outstanding senior in the Geology Department at Virginia Polytechnic Institute.

The Virginia Department of Highways has published a 70-page bulletin giving the results of physical tests made in connection with their state-wide aggregate survey. More than 2,200 samples were collected and tested in the six-year period of the survey.

Mr. A. B. Cornthwaite, testing engineer, Mr. James Eades, research engineer, and Mr. W. T. Parrott, highway geologist, represented the Virginia Department of Highways at the Fifth Annual Meeting of the "Symposium on Geology as Applied to Highway Engineering" held at Columbus, Ohio. Approximately 150 geologists and engineers from a dozen states attended the meetings.

Dr. Joseph T. Singewald, Jr., professor of economic geology at Johns Hopkins University and director of the Maryland Department of Geology, Mines, and Water Resources, discussed the "Geology and Mineral Resources of Argentina" at the symposium of the Holden Society in connection with the annual Engineering Emphasis Week Program at Virginia Polytechnic Institute.

The Geology Department at Virginia Polytechnic Institute is inaugurating a state-wide study of Virginia building stones. Specimens from all producing areas and other selected localities will be obtained, subjected to laboratory studies, and set into an L-shaped stone wall for long-range observations of their individual weathering and durability characteristics.

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Sandstone and flagstones of possible use for building purposes in the vicinity of the campus will be studied first. Stone for Carol M. Newman Library, now under construction, was selected with the advice and assistance of the geology staff, with the objective of avoiding the somber hue characterizing so many of Virginia's native stone building. The stone being used in construction of the Library is of three types: a bluish-black limestone; a white to light-gray dolomite; and a gray dolomite. Each type of stone weathers a different color.

The Geology Department working under the Virginia Engineering Experiment Station, located at Virginia Polytechnic Institute, is undertaking the following new studies: *Mineralogy of Mine Roof Rocks*—a study of the clay and iron-bearing minerals contributing to the strength and structural integrity of roof rocks in Virginia coal mines; principal investigator, Mr. Carl T. Meyertons. *Virginia Dolomites* — field and petrographic study of typical Appalachian dolomite-calcite carbonate rocks with the objective of working out the origin of the rocks; principal investigator, Mr. Charles R. B. Hobbs, Jr. *Petrography and Mineralogy of Virginia Coals*: field and petrographic studies of selected coal beds from the Appalachian Coal Measures with the objective of determining whether these coals can be separated into mineral fractions of special use for industrial purposes; principal investigator, Mr. J. J. Crabb. Mr. Crabb joins the geology staff September 1, 1954, as assistant mineral technologist and assistant professor of geology. *Feldspar-bearing Pegmatites of the Bedford District*—field and laboratory study of the pegmatite-bearing body of crystalline rocks in the areas covered by the Goode and Peaks of Otter quadrangles in Virginia; principal investigators, Mr. William E. Diggs and Mr. George M. Deaton.

A geochemical laboratory is being set-up by the Department of Geology, Virginia Polytechnic Institute. Vegetation, soil, and water analyses will be made in conjunction with the department's investigations of Virginia mineral resources.

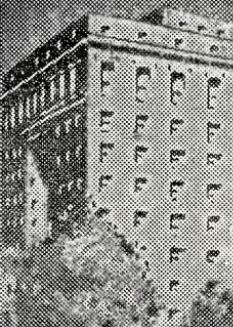
"Geology of the Pilot Mountain Area, Virginia" by R. V. Dietrich was recently published as Bulletin 91 of the Virginia Engineering Experiment Station. The area covered by this report is approximately 175 square miles in Southern Montgomery County.—W. D. LOWRY.

PSYCHOLOGICAL SECTION

The Virginia Examining Board for Clinical Psychologists has recently certified the following psychologists: (1) by reciprocity, Harold N. Hildreth and Charles A. Ullman, both of Arlington; (2) by examination, Samuel S. Dublin, Robert J. Filer, Frederick S. Hauser, Cyril R. Mill, David H. Orr, and Ewing L. Phillips. William M. Hinton was reelected chairman of the Examining Board. Serving with Mr. Hinton on the Board at the present time are the following: Mrs. Catherine T. Giblette, Austin E. Grigg, Richard H. Henneman, and Dr. Gilbert J. Rich.

At its regular meeting in May, the Richmond Psychological Association elected the following officers for 1954-55: President, Dr. Cyril R. Mill,

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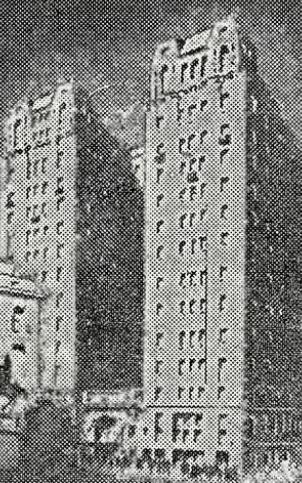
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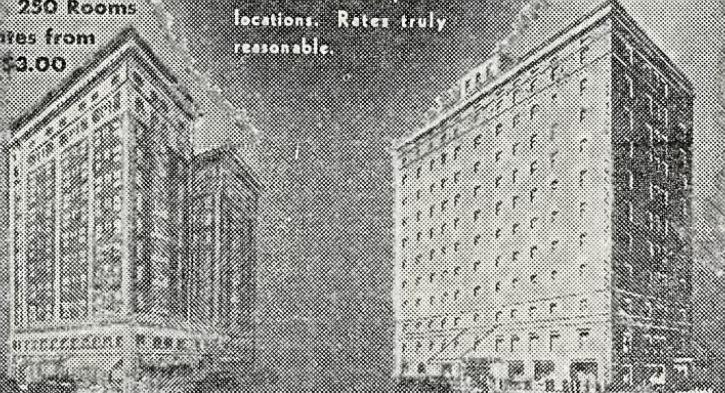
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Richmond Public Schools; Vice-President, Dr. Robert J. Filer, University of Richmond, and Secretary-Treasurer, Dr. Jacob Silverberg, McGuire Veterans Hospital.

Several Virginia psychologists appeared on the program of the 46th annual meeting of the Southern Society for Philosophy and Psychology held in Atlanta, April 15-17. Mr. Frank A. Geldard was chairman of a symposium, *Regional Research and Training Activities in Psychology*; Richard H. Henneman, of the University of Virginia, and Morris Roseman, of the Veterans Administration Hospital in Roanoke, presented papers at the regular sessions. William M. Hinton serves the Society as Treasurer.

At the National Conference on Airborne Electronics held in Dayton, Ohio, on May 10-12, Mr. Henneman read a paper, "A Comparison of the Visual and Auditory Senses as Channels for Data Presentation". This paper included library and laboratory research carried on at the University of Virginia under a research contract with the U. S. Air Force.

Newcomers to state academic circles in the past year were Robert J. Filer at the University of Richmond, and Frederick S. Hauser at Hollins College.

Visiting professors of psychology who will be on the faculty of the Summer School at the University of Virginia are Prof. Henry E. Garrett of Columbia University, distinguished alumnus of the University of Richmond, and former president of the American Psychological Association; Prof. Robert C. Wingfield of Converse College; and Prof. William M. Hinton of Washington and Lee University.

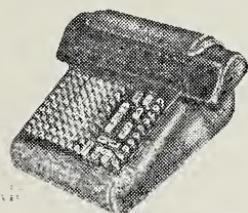
Mr. Frank W. Finger, who spent the academic session of 1953-54 on leave at Yale University, attended the International Congress of Psychology at Montreal, June 7-11.—RICHARD H. HENNEMAN.

STATISTICS SECTION

The Southern Regional Graduate Summer Session in Statistics, sponsored by Virginia Polytechnic Institute, University of Florida, Consolidated University of North Carolina, and the Southern Regional Education Board began July 9, 1954, at Virginia Polytechnic Institute. The faculty for this session includes R. A. Bradley, Virginia Polytechnic Institute; David B. Duncan, Virginia Polytechnic Institute; Ralph E. Comstock, North Carolina State College; Bernie G. Greenberg, University of North Carolina; Boyd Harshbarger, Virginia Polytechnic Institute; Burt C. Horne, Jr., University of North Carolina; Maurice G. Kendall, North Carolina State and University of London, London, England; Roger L. Smith, Virginia Polytechnic Institute; Paul N. Somerville, Virginia Polytechnic Institute; and M. C. Kenneth Tweedie, Virginia Polytechnic Institute who are teaching scheduled classes. There are R. C. Bose, University of North Carolina; W. F. Callander, University of Florida; C. A. Bicking, Department of the Army; James W. Johnston, Jr., Georgetown University; G. L. Edgett, Queen's University, Canada and Virginia Polytechnic Institute; Gertrude Cox, North Carolina State; H. H. Chapman, University of Florida; George F. Gant, Southern Regional Education Board; Besse Day and Francis

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Del Priore, Naval Engineering Experiment Station; W. A. Hendricks, U. S. Department of Agriculture; and F. J. Anscombe, Princeton University and the University of Cambridge, England who are giving seminars. There are 85 students enrolled. The students come from 24 states and India, Australia, Finland, Canada, Hawaii, the Philippines and China.

Dr. John E. Freund of the Department of Mathematics, Alfred University, New York will join the staff at the Virginia Polytechnic Institute Statistics Department as a visiting professor September 1, 1954. He will replace Dr. Edgett as chief investigator on a contract with the Department of Ordnance. Dr. Freund studied at the University of London, University of California, Columbia University, and University of Pittsburgh. Dr. Freund has published the following: *Modern Elementary Statistics*. New York: Prentice-Hall, 1952; *Elementary College Mathematics*. New York: Prentice-Hall, 1953 (Preliminary Mimeographed Edition); collaborated on the translation from German of Hans Reichenbach's *Philosophy of Space and Time*. (Will be published soon by the University of California Press.) He has also published the fol-

lowing articles: "Segment Functions", "Statistical vs. Pragmatic Inference", "Simplified Computation of the Tetrachoric Correlation Coefficient", "The Degree of Stereotypy", "On the Confirmation of Scientific Theories", "On the Problem of Confirmation", "The Transfer Distribution", "On the Utilization of Direct as well as Collateral Information in Problems of Statistical Estimation", "Some Observations on Laplace's Rule of Succession and Perk's Rule of Indifference", and "The Bivariate Binomial Distribution and Applications".

The following were awarded Master of Science Degrees with a major in statistics at Virginia Polytechnic Institute on June 6, 1954: Robert M. Ableson, William H. Beyer, Edwin Bleicher, Robert G. Bonner, Richard G. Cornell, Patricia A. Ripley, Vincent Schultz, John C. Layman, Paul Sanders.
—LIONEL WEISS.

THE ANNUAL SUBSCRIPTION rate is \$3.00, and the cost of a single number, \$1.00. Reprints are available only if ordered when galley proof is returned. All orders except those involving exchanges should be addressed to Boyd Harshbarger, Virginia Polytechnic Institute, Blacksburg, Virginia. The University of Virginia Library has exclusive exchange arrangements, and communications relative to exchange should be addressed to The Librarian, Alderman Library, University of Virginia, Charlottesville, Virginia.

NOTICE TO CONTRIBUTORS

Contributions to the Journal should be addressed to Horton H. Hobbs, Jr., Miller School of Biology, University of Virginia, Charlottesville, Virginia. If any preliminary notes have been published on the subject which is submitted to the editors, a statement to that effect must accompany the manuscript.

Manuscripts must be submitted in triplicate, typewritten in double spacing on standard 8½" x 11" paper, with at least a one inch margin on all sides. Manuscripts are limited to seven pages, with the proviso that if additional pages are desired, the author may obtain them at cost.

Division of the manuscript into subheadings must follow a consistent plan, and be held to a minimum. It is desirable that a brief summary be included in all manuscripts.

Footnotes should be included in the body of the manuscript immediately following the reference, and set off by a dashed-line above and below the footnote content. Footnotes should be numbered consecutively from the beginning to the end of the manuscript.

Bibliographies (Literature Cited, References, etc.) should be arranged alphabetically according to author. Each reference should include the date, full title of the article, the name of the Journal, the volume, number (optional), pages, tables and figures (if any). For example: "Sniffen, Ernest W. 1940. Cobbles from the Pleistocene Terraces of the Lower York-James Peninsula, Va. *Journ. Sci.* 1 (8): 285-288, 1 fig. 1 tab. Reference to the bibliographic citations should not be made by numbers. Instead, using the above citations, where a reference is desired; either "Sniffen (1940)", "Sniffen, 1940: 186)", or "Sniffen (1940) states that . . .".

Explanations of figures, Graphs, etc., should be typed on separate pages. All figures should be numbered consecutively beginning with the first text figure and continuing through the plates. If figures are to be inserted in the text this should be clearly indicated by writing "Figure —" at the appropriate place in the margin.

Illustrations, including lettering, should be arranged so that on reduction they will not exceed the dimensions of the maximum size of a printed page, 4½" x 6½", and so that they are well balanced on the page. The Journal will furnish the author with one plate (halftone or line reproduction) or its equivalent; additional figures, colored illustrations or lithographs may be used only if the author makes a grant covering the cost of production. Original drawings (which must be done in black drawing ink), not photographs of drawings, should accompany the manuscript. Photographs should not be used if a line and dot (stripped) drawing will suffice. If photographic prints are to be used they should be glossy, sharp and show good contrast. Drawings not neatly executed and labeled (do not use a typewriter), or which are submitted on yellow or yellowish-white paper will not be accepted.

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THE VIRGINIA JOURNAL OF SCIENCE

A JOURNAL ISSUED QUARTERLY BY THE
VIRGINIA ACADEMY OF SCIENCE

PROCEEDINGS FOR THE YEAR

1953 - 1954





VOL. 5, NEW SERIES

SEPTEMBER, 1954

No. 4

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CONTENTS

	Pages
Proceedings for the Year 1954-1955	
Minutes of the Thirty-Second Annual Meeting May 5, 6, 7, 8, 1954	
Detailed Table of Contents	198-199

EDITORIAL BOARD

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Mailed December 24, 1954

THE VIRGINIA JOURNAL OF SCIENCE

VOL. 5, NEW SERIES

No. 4

VIRGINIA ACADEMY
OF SCIENCE



Proceedings for the Year
1953--1954

MINUTES OF THE THIRTY-SECOND ANNUAL MEETING

MAY 5, 6, 7, 8, 1954

AT THE UNIVERSITY OF VIRGINIA
CHARLOTTESVILLE, VIRGINIA

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Contents

LIST OF PRESIDENTS	192
OFFICERS AND COMMITTEES FOR 1953-45	193
OFFICERS AND COMMITTEES FOR 1954-55	194
JEFFERSON MEDAL WINNERS	200
HORSLEY AWARD	200
GENERAL PROGRAM--THIRTY-SECOND ANNUAL MEETING	202
TABULATION OF REGISTRATION	204
MINUTES OF COUNCIL MEETING	205
MINUTES OF ACADEMY CONFERENCE	206
MINUTES OF ACADEMY MEETING	207
MINUTES OF COUNCIL MEETING	209
REPORTS OF	
Secretary-Treasurer	211
Committees:	
Long Range Planning	220
Research	220
Finance and Endowment	221
Junior Academy of Science	223
Ninth Science Talent Search	225
Membership	227
James River Project	228
Resource-Use Education	229
Virginia Flora	230
Speakers and Counselors	230
Resolutions	230
Virginia Institute of Scientific Research	231
Virginia Journal of Science	233

MINUTES OF SECTIONS

Agricultural Sciences	235
Astronomy, Mathematics, and Physics	243
Bacteriology	254
Biology	258
Chemistry	267
Education	280
Engineering	285
Geology	296
Medical Sciences	310
Psychology	320
Science Teachers	330
Statistics	332
LIST OF MEMBERS	341
LIST OF STUDENT MEMBERS	341
MEMBERSHIP APPLICATION	369
FORM OF BEQUEST	369

JEFFERSON MEDAL WINNERS

RECIPIENTS OF THE JEFFERSON GOLD MEDAL¹

Alfred Chanutin	1936
William B. Porter	1937
H. M. Phillips	1938
G. M. Shear and H. D. Ussery	1939

RECIPIENTS OF THE JEFFERSON PRIZE²

L. G. Overholzer and John H. Yoe	1940
Allan T. Gwathmey	1941
R. N. Jefferson	1942
W. H. Hough	1943
Clinton B. Cosby	1944

RECIPIENTS OF J. SHELTON HORSLEY RESEARCH AWARDS

Carl C. Speidel	1927
John H. Yoe	1928
J. C. Street	1929
H. E. Jordan	
Carl C. Speidel	1930
E. C. Stevenson	1931
James H. Smith	1932
S. A. Wingard	1933
E. P. Johnson	1934
Margaret Hess	1935
Alfred Chanutin	1936
R. G. Henderson	1937
S. G. Bedell	1938
M. J. Murray	
F. F. Cleveland	1939
Walton C. Gregory	1940
Charles Ray	1941
No Award	1942
J. B. Meyer	1943
J. H. Taylor	1944
No Award	1945
Boyd Harshbarger and D. B. DeLury (separate papers)	1946
No Award	1947
Henry Leidheiser, Jr.	1948
Walter S. Flory, Jr.	1949

¹ The winning papers in this competition were entered against those of the North Carolina, South Carolina, Georgia, and Florida Academies of Science. It was discontinued in 1940.

² The winning authors had the choice of the Jefferson Prize or the Academy Prize during this period. The name of the Academy Prize was changed to the J. Shelton Horsley Award; and the Jefferson Prize discontinued in 1944.

Erling S. Hegre	1950
David B. Duncan	1951
D. R. H. Gourley	1952
Stephen Berko	
Frank L. Hereford	1953
Lynn D. Abbot, Jr. and Mary J. Dodson	1954

*General Program of
The Thirty-Second Annual Meeting
1954*

UNIVERSITY OF VIRGINIA
CHARLOTTESVILLE, VIRGINIA
WEDNESDAY, MAY 5

- 3:00 P.M. to 8:00 P.M.—Registration for Junior Academy Members,
Participants in the Science Talent Search—Main Lobby,
Cabell Hall.
- 3:00 P.M. to 8:00 P.M.—Arranging Exhibits—Cabell Hall Basement.

THURSDAY, MAY 6

- 8:00 A.M. to 5:00 P.M.—Registration for Junior Academy Members,
Senior Academy Members and Guests—Main Lobby, Cabell Hall.
- 9:00 A.M.—Meeting of Science Exhibit Judges, Science Talent Search
Judges—Rooms 428, 451, Cabell Hall.
- 9:30 A.M.—Meeting of Chairman and Exhibitors, and Science Talent
Search Participants—Cabell Hall Auditorium.
- 10:00 A.M. to 12:30 P.M. and 1:30 to 4:00 P.M.—Finalists of Talent
Search meet with Chairman and Interviewers—Cabell Hall,
Rooms 428, 451, 254, 255.
- 10:00 A.M. to 12:30 P.M. and 1:30 to 4:00 P.M.—Judging of Science
Exhibit Contests—Cabell Hall Basement.
- 3:30 P.M.—Meeting of all Senior Academy Section Officers—Room
122, Cobb Chemical Laboratory.
- 4:00 P.M.—Meeting of the Section Editors—Room 100, Cobb Chemical
Laboratory.
- 5:00 P.M.—Senior Academy Conference and General Meeting—Auditorium,
Cabell Hall.
- 7:30 P.M.—Business Meeting, Junior Academy of Science—Auditorium,
Cabell Hall.
- 8:30 P.M.—Address of Guest Speaker for Junior Academy Members
and Guests—Auditorium, Cabell Hall.
- 9:30 P.M.—Meeting of Virginia Junior Academy of Science Commit-
tee—Cabell Hall.

FRIDAY, MAY 7

- 8:30 A.M.—Registration—Main Lobby, Cabell Hall.
- 9:00 A.M.—Section Meetings: *Agricultural Sciences*—Room 118, Cabell Hall; *Astronomy, Mathematics, and Physics*—Rouss Physical Laboratory; *Bacteriology*—Room 311, Cabell Hall; *Biology*—Maury Hall; *Chemistry*—Room 200, Cobb Chemical Laboratory; *Education*—Room 122, Cabell Hall; *Engineering*—Room 39, Thornton Hall; *Geology*—Room 244, Cabell Hall; *Medical Sciences*—Amphitheater, Medical School; *Psychology*—Peabody Hall; *Science Teachers*—Room 122, Cobb Chemical Laboratory; *Statistics*—Room 243, Cabell Hall.
- 10:00 A.M. to 11:30 A.M.—Symposium, “What’s New in Physics”, sponsored by Science Teachers Section—Room 200, Cobb Chemical Laboratory (see program of Science Teachers Section).
- 12:00 Noon to 1:00 P.M.—JUNIOR-SENIOR SCIENTIST HOUR *at which Awards will be presented*—Auditorium, Cabell Hall.
- 2:00 P.M.—Section Meetings.
- 4:45 P.M. to 6:00 P.M.—The University of Virginia will be host at a tea to the Members and Guests of the Academy — Rotunda.
- 7:45 P.M.—Short Business Meeting, Senior Academy — Auditorium, Cabell Hall.
- 8:30 P.M.—Address by Dr. J. A. Becker, Bell Telephone Laboratories, “Seeing and Counting Atoms” with the New Field Emission Microscope”—Auditorium, Cabell Hall.
- SATURDAY, MAY 8
- 9:00 A.M.—Section Meetings.
- 10:00 A.M.—Academy Council Meeting — Conference Room, Cobb Chemical Laboratory.

Tabulation of Registration

<i>Section</i>	<i>Members</i>	<i>Non-members</i>	<i>Total</i>
1. Agricultural Sciences	15	10	25
2. Astronomy, Mathematics, and Physics	44	32	76
3. Bacteriology	4	1	5
4. Biology	75	24	99
5. Chemistry	63	48	111
6. Education	9	4	13
7. Engineering	14	8	22
8. Geology	18	11	29
9. Medical Sciences	26	10	36
10. Psychology	29	9	38
11. Science Teachers	13	3	16
12. Statistics	9	13	22
No Section Preference	18	35	53
TOTAL	337	208	545
JUNIOR REGISTRATION			155
TOTAL REGISTRATION			700

MINUTES OF THE COUNCIL MEETING MAY 6, 1954

A meeting of the Council of the Virginia Academy of Science was held in Room 02, Cobb Chemical Laboratory, University of Virginia, 2:30 P.M., May 6, 1954. Present were Walter S. Flory, President-Elect I. G. Foster, Horton H. Hobbs, Jr., Guy W. Horsley, Ladley Husted, Sidney S. Negus, Paul M. Patterson, and Foley F. Smith. President Allan T. Gwathmey presided. Boyd Harshbarger was present at the latter part of the meeting.

Dr. Guy W. Horsley discussed the auditor's report in detail and discussed details of the budget to cover the remainder of the calendar year 1954 and the tentative budget for 1955. The Council unanimously moved to recommend to the Academy Conference that all surplus funds in all Academy accounts be set up in one account with the First and Merchants National Bank of Richmond in short term securities, to earn additional income for the Academy. It was moved, seconded, and passed that the budget be accepted as submitted by the Finance Committee and recommended for approval by the Conference.

The new Business Membership Classification was discussed. Efforts will be made to secure more members in this classification.

The streamlined Academy Conference as inaugurated last year was discussed in detail as opposed to the former method of having verbal reports of all committees made at the Conference. It was decided that this question would be brought up before the Conference by President Gwathmey and left for its decision.

It was agreed that the Junior Academy activities on Friday evening could be moved up (early enough) so that the Conference could begin at 9 o'clock, if this was the desire of the majority present at the Conference.

The question of getting the program of the Annual meeting as far in advance as possible was brought up, and it was agreed that early distribution of the separate copies would greatly aid the Public Relations program of the Academy.

Boyd Harshbarger emphasized the necessity of having all abstracts and other copy for the Proceedings in his hands by May 20.

The meeting adjourned at 4 P.M.

FOLEY F. SMITH, *Secretary*

MEETING OF THE ACADEMY CONFERENCE MAY 6, 1954

The annual meeting of the Academy Conference was held in the auditorium of Cabell Hall, University of Virginia, May 6, 1954, at 5 P.M. A quorum of more than forty members being present, President Gwathmey called the meeting to order and welcomed both the Junior and Senior Academies on behalf of the University of Virginia. The reading of the minutes of the previous Academy Conference was heard.

The recommendation of Council concerning the time of the next Conference was discussed, and it was moved, seconded, and passed that the Conference next year be held after the Junior Academy activities are over.

Reports of the various committees were made. No report was received from the Fauna Committee or the Science Museum Committee.

There being no further business, the meeting adjourned at 6:05 P.M.

FOLEY F. SMITH, *Secretary*

MINUTES OF THE ACADEMY MEETING

MAY 7, 1954

The annual meeting of the Academy was held in the auditorium of Cabell Hall, University of Virginia, 7:30 P.M. President Gwathmey presided, and the reading of the minutes of the last business meeting was heard.

President Gwathmey again presented greetings to the Academy on behalf of the University, and expressed the regrets of President Colgate Darden that he could not be present.

President Gwathmey recognized Dr. Raymond L. Taylor, Assistant Administrative Secretary of the American Association for the Advancement of Science, who extended official greetings to the Academy on its thirty-second meeting, from the officers and administrative staff of the Association.

Dr. Gwathmey at this time recognized the Honorable John S. Battle, former Governor of Virginia, and expressed the gratitude of the Academy for his help in the formation of the Virginia Institute of Scientific Research and for his keen interest in science in Virginia.

William E. Trout, Jr. gave the report of the Resolution Committee. It was moved, seconded, and passed that it be received.

Ladley Husted gave the report of the Place-of-Meeting Committee and read an invitation from Dr. G. Tyler Miller, President of Madison College, Harrisonburg, to hold the next annual meeting there. It was moved, seconded, and passed that the invitation be tentatively accepted. (These reports follow the other Committee reports.)

Paul M. Patterson gave the report of the Nominating Committee in the absence of Dr. Guy W. Horsley. The following nominees were unanimously elected for the coming year: I. G. Foster, *President*; Foley F. Smith, *Secretary-Treasurer*; Walter S. Flory, *President-Elect*.

William Hinton was elected to the Council for a period of five years.

Byron N. Cooper was elected to the Council for a term of four years, filling the remaining four-year term of Walter S. Flory.

E. C. L. Miller, Secretary-Treasurer Emeritus of the Academy, was permanently elected to this office.

Walter S. Flory, Chairman of the Research Committee, gave a brief sketch of the origin of the Research Committee in 1926-1927 under Dr. J. Shelton. In 1947 the name of the Academy prize was changed to the J. Shelton Horsley Award. This year, of 225 papers presented before the Academy sections, 9 were submitted in competition for this award. Honorable mention was given to the paper presented before the Section of Agricultural Sciences by J. S. Copenhaver and W. B. Bell of the Virginia Agricultural Experiment Station on "The Production of Bovine Hyperkeratosis (X-disease) with an Experimentally Made Pellet Feed."

In 1954, the J. Shelton Horsley award was won by Dr. Lynn D. Abbott, Jr. and Mary J. Dodson of the Medical College of Virginia for their paper

presented before the section of Medical Sciences on "Inhibition of In Vitro Heme Synthesis from N⁵ Glycine by 2, 5-Dimethylbenzimidazol, 5, 6-Dimethylbenzimidazol, and Related Compounds."

Dr. Abbot gave a brief synopsis of the purpose and results obtained in this outstanding study.

I. G. Foster of the Virginia Military Institute, newly elected President, was recognized by President Gwathmey.

The business meeting adjourned at 8:25 P.M. and reconvened at 8:30 to hear a very interesting talk by Dr. Joseph A. Becker of the Bell Telephone Laboratories on "Seeing and Counting Atoms with the New Field Emission Microscope." A demonstration of this instrument was made by Dr. Shelley of the Chemical Faculty, University of Virginia, during Dr. Becker's talk.

FOLEY F. SMITH, *Secretary*

MINUTES OF THE COUNCIL MEETING MAY 8, 1954

A meeting of the Council of the Virginia Academy of Science was held in the Conference room, Cobb Chemical Laboratory, May 8, 1954, 10 A.M. Present were Boyd Harshbarger, Horton Hobbs, President-Elect Walter S. Flory, Allan Gwathmey, Paul M. Patterson, Stanley B. Williams, and Foley F. Smith. President I. G. Foster presided and recognized Mrs. Thelma Heatwole, Chairman of the Junior Academy of Science Committee, and Edward R. Dyer, Chairman of the Science Talent Search Committee, who were present by invitation.

The Committee on Science Teaching reported that it was unable to get funds through the State Board of Education and that it was even impossible to secure from them a list of Science Teachers in the State. The possibility of the Academy securing a current list of Science Teachers was discussed.

Edward Harlow of the American Tobacco Research Laboratory of Richmond was appointed Chairman of the Long-Range Planning Committee, succeeding Marcellus Stow, who resigned.

Sidney S. Negus pointed out that the "Buddy idea" inaugurated at this meeting had drawn attention from the Scientific Man Power Committee, AAAS, the American Chemical Society, and the National Science Foundation. It was felt that this idea is highly successful and that it should be continued. Senior members in the various fields of science were selected to escort members of the Junior Academy during the Friday morning sessions.

The Council expressed its heartfelt thanks to Mrs. Heatwole and Dr. Dyer for their most excellent efforts in making the meeting of the Junior Academy and the Ninth Science Talent Search outstanding.

The Speaker's Bureau was discussed, and it was felt that the committee should be continued another year on a regional basis.

It was suggested that President-Elect Flory secure from Madison College more detailed information concerning the housing facilities and other details of the annual meeting to present at the fall meeting of the Council before the final acceptance of the invitation to meet there next May.

Boyd Harshbarger advised the Council of his appointment of Dr. Richard Irby, Jr. of the American Tobacco Research Laboratory as Advertising Manager of the Journal. It was moved, seconded, and unanimously passed that the Editorial Board and Horton H. Hobbs, Technical Editor, be officially extended the thanks and gratitude of the Council for their excellent work in the publication of the Journal. It was also moved, seconded, and passed that Malcolm Donald Coe, publisher of *The Giles County Virginian* be thanked for his efforts in publishing the Virginia Journal of Science. It was suggested that President Foster write Dr. E. C. L. Miller extending the regrets of the Academy for his absence from this annual meeting and Dr. Russell Rowlett of the Virginia-Carolina Chemical Com-

pany thanking him for his outstanding work as Chairman of the Public Relations Committee.

The meeting adjourned at 12:15 P.M.

FOLEY F. SMITH, *Secretary*

REPORT OF THE SECRETARY-TREASURER

This, the Thirty-second meeting of the Academy, is the first under the new fiscal or calendar year and officially represents the business of the Academy from April 1, 1953, to January 1, 1954. While there are still a few minor problems in connection with the change-over, I believe that the efficiency of all business affairs of the Academy will be greatly increased, and the previous confusion of having a different membership year, auditing year, and subscription year will be eliminated.

The audit and the report of the Finance committee also covers this period, but the budget will cover what has been spent since January 1, 1954, and what can be spent during the baalnce of calendar year.

The addressograph plates of the Academy were placed in the hands of a commercial mailing firm in Richmond, which has already resulted in greater service being rendered the individual sections of the Academy.

The Academy was represented at two AAAS Council metings in Boston, Mass., December 26-31, 1953, by the Secretary and represented at the AAAS Academy Conference by the Secretary, President Allan T. Gwathmey, and Mrs. Thelma Heatwole. At the morning session President Gwathmey presented a resumé of the Virginia Academy's projects and activities. Mrs. Heatwole presented a paper at the afternoon panel on Junior Academy activities.

The AAAS Council announced the appointments and acceptance of the following officers to replace the devoted services of Dr. Meyerhoff and Mrs. Gladys Keener: Dr. Dael Wolfe, former Executive Secretary and Dr. Duane Roller, Assistant Director of Research, Hughes Research and Development Laboratories, California, as Editor of publications. Dr. Paul Scherer, Executive Officer of the Carnegie Institute of Washington, was appointed Treasurer to replace Dr. Wrather, who resigned.

George W. Beadle, Professor of Biology and Chairman of the Division of Biology, California Institute of Technology, was voted President-Elect of the Association.

During the year, \$2,000 of accumulated funds in the Research Fund checking account were invested and will be noted in the report of the Finance Committee.

At the November meeting of the Council, it was decided to establish a new membership classification known as a "Business Membership", dues for which are \$100.00 per year. This revenue will be used for the annual operation of the Junior Academy and Science Talent Search and other purposes at the direction of Council.

Due to the activities of President Gwathmey and Dr. Guy Horsley, I'm happy to report that seven such members have been received this year as follows: Virginia Electric and Power Company, Richmond; E. I. duPont de Nemours and Company, Richmond; Allied Chemical and Dye Corporation, Nitrogen Division, Hopewell; A. H. Robbins Company, Richmond; Monsanto Chemical Company, Norfolk; Phipps and Bird, Inc., Richmond; and the Newport News Shipbuilding and Dry Dock Corporation, Newport News.

FOLEY F. SMITH, *Secretary.*

**FINANCIAL STATEMENT
VIRGINIA ACADEMY OF SCIENCE
CONSOLIDATED FUND BALANCE SHEET
DECEMBER 31, 1953
SCHEDULE A
ASSETS**

GENERAL FUND:

Cash in Bank (Exhibit "B")	\$ 2,717.26
Investments (At Cost):	
Preferred Stocks (Market Value \$2,359.00)	2,445.95
<i>Total General Fund</i>	\$ 5,163.21

RESEARCH FUND:

Cash in Bank (Exhibit "C")	\$ 214.86
Due from Trust Agent—Accumulated Income	
Account (Temporary Investment)	2,000.00
<i>Total Research Fund</i>	2,214.86

TRUST FUND PRINCIPAL ACCOUNT (Note 1):

Cash on Deposit (Exhibit "D")	\$ 440.85
Investments (At Cost):	
United States Savings Bonds	
Series "F" and "G" (Market Value	
\$6,345.00)	\$ 6,337.00
Stock Securities (Market Value	
\$9,305.25)	7,430.29
5% Real Estate Note (Secured	
by First Deed of Trust)	1,400.00
	15,167.29
<i>Total Trust Fund Principal Account</i>	15,608.14

TRUST FUND PRINCIPAL ACCOUNT—INVESTMENT**INCOME ACCOUNT (Note 1):**

Cash on Deposit (Exhibit "E")	\$ 346.25
<i>Total Trust Fund Principal—</i>	
<i> Investment Income Account</i>	346.25

TRUST FUND ACCUMULATED INCOME ACCOUNT (Note 1):

Cash on Deposit (Exhibits "F" and "G")	\$ 32.13
Investments (At Cost) (Market Value	
3,448.50)	3,791.48
<i>Total Trust Fund Accumulated Income Account</i>	3,823.61
	\$27,156.07

LIABILITIES AND FUND SURPLUS

GENERAL FUND:

Advance Payment on Dues	\$ 409.00
Due to the Virginia Journal of Science	166.84
Fund Balance	4,587.37
<i>Total General Fund</i>	\$ 5,163.21

RESEARCH FUND:

Fund Balance	\$ 2,214.86
<i>Total Research Fund</i>	\$ 2,214.86

TRUST FUND PRINCIPAL ACCOUNT:

Fund Balance, December 31, 1953	\$15,608.14
<i>Total Trust Fund Principal Account</i>	15,608.14

TRUST FUND PRINCIPAL ACCOUNT--

INVESTMENT INCOME ACCOUNT:

Fund Balance—April 1, 1953	\$ 115.75
Add—Excess of current year's income over income distribution (Exhibit "E").....	230.50
Fund Balances—December 31, 1953	\$ 346.25
<i>Total Fund Principal Account—</i>	
<i>Investment Income Account</i>	346.25

TRUST FUND ACCUMULATED INCOME ACCOUNT:

Due to Virginia Academy of Science— Research Fund (Temporary Investment) ...\$ 2,000.00	
Fund Balance—April 1, 1953 ...\$ 1,807.23	
Add—Excess of current year's income over income distribution (Exhibit "F")	16.38
Fund Balance—December 31, 1953	1,823.61
<i>Total Trust Fund Accumulated Income Account</i>	3,823.61
	<u>\$27,156.07</u>

GENERAL FUND

STATEMENT OF CASH RECEIPTS AND DISBURSEMENTS
FOR THE PERIOD APRIL 1, 1953, TO DECEMBER 31, 1953

EXHIBIT "B"

BALANCE ON DEPOSIT--APRIL 1, 1953 \$ 2,665.95

RECEIPTS:

Revenues:

Dues:

Regular Members	\$ 738.00
Collegiate Members	50.00
Contributing Members	80.00
Delinquent Dues for Prior Years Collected	37.00 \$ 935.00

Gifts, Grants and Bequests:

Virginia Junior Academy of Science	500.00
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Non-Revenue:

Advance payment of dues	\$ 398.00
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Special contributions for Science Talent Search	235.00
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Collections for May 1953 meeting shown as deduction of meeting expenses:	
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Sales of Booth Space	\$ 90.00
Registration Fees	247.00
	\$337.00

Dividends from Stock Investments	79.05
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Refund on prior year's publication for Virginia Junior Academy of Science	27.91
	739.96

<i>Total Receipts</i>	2,174.96
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	\$ 4,840.91
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DISBURSEMENTS:

American Association for Advancement of	
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Science Meeting	\$ 170.00
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Junior Academy of Science	371.44
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Annual Meeting Expenses:	
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Total Expenses Incurred
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and Paid	\$ 369.02
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Proceeds from Sales of Booth	
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Space and Registrations	337.00
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	32.02
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Miscellaneous General Expenses	
(Schedule "1")	279.74
Postage and Express	104.71
Printing	113.57
Science Talent Search	786.40
Stationery, Supplies and Stenographic Services	77.11
The Virginia Journal of Science (Schedule "2")	128.66
Dr. E. C. L. Miller Award	50.00
W. Catesby Jones Award	10.00
<i>Total Disbursements</i>	\$ 2,123.65

BALANCE--DECEMBER 31, 1953 (Exhibit "A") \$ 2,717.26

CONSISTING OF:

Cash on Deposit First and Merchants National Bank of Richmond—Checking Account	
General Fund	\$ 2,019.95
Science Talent Search	540.84
Virginia Junior Academy of Science	156.47
<i>Total</i>	\$ 2,717.26

RESEARCH FUND

STATEMENT OF CASH RECEIPTS AND DISBURSEMENTS FOR THE PERIOD APRIL 1, 1953, TO DECEMBER 31, 1953

EXHIBIT "C"

BALANCE ON DEPOSIT—APRIL 1, 1953 \$ 2,587.39

RECEIPTS:

Revenues:

Income from Trust Investments	\$ 284.26
Gifts, Grants and Bequests	100.00
Refund on Prior Year's Grant-In-Aid	60.85

<i>Total Receipts</i>	445.11
<i>Total</i>	\$ 3,032.50

DISBURSEMENTS:

Investment funds to Trust Agent, First and Merchants National Bank of Richmond	\$ 2,000.00
Grant-In-Aid Awards	800.00
Miscellaneous Expense	17.64

<i>Total Disbursements</i>	2,817.64
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BALANCE ON DEPOSIT—DECEMBER 31, 1953

BALANCE ON DEPOSIT—DECEMBER 31, 1953 (Exhibit "A")	\$ 214.86
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CONSISTING OF:

Cash on Deposit First and Merchants National Bank of Richmond—Checking Account	\$ 214.86
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TRUST FUND PRINCIPAL ACCOUNT—PRINCIPAL CASH ACCOUNT
STATEMENT OF CASH RECEIPTS AND DISBURSEMENTS
FOR THE PERIOD APRIL 1, 1953, TO DECEMBER 31, 1953

EXHIBIT "D"

BALANCE—APRIL 1, 1953	\$ 1,169.73
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RECEIPTS:

Proceeds from Federal Government Bonds maturing in August 1953	\$ 1,500.00
Proceeds from payment on principal of Real Estate First Deed of Trust Note	300.00
<i>Total Receipts</i>	1,800.00
	\$ 2,969.73

DISBURSEMENTS:

Purchase of 25 Shares of Illinois Power Company Common Stock	\$ 1,011.08
Purchase of 20 Shares of America Tobacco Company Common Stock	1,517.80
<i>Total Disbursements</i>	2,528.88

BALANCE—DECEMBER 31, 1953	\$ 440.85
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CONSISTING OF:

Cash on Deposit with Depository Bank of the Trust Agent, First and Merchants National Bank of Richmond..	\$ 440.85
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TRUST FUND PRINCIPAL ACCOUNT--

INVESTMENT INCOME CASH ACCOUNT

STATEMENT OF CASH RECEIPTS AND DISBURSEMENTS
FOR THE PERIOD APRIL 1, 1953, TO DECEMBER 31, 1953

EXHIBIT "E"

BALANCE—APRIL 1, 1953	\$ 115.75
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RECEIPTS:

Revenue:

Dividends on Stock Investments	\$ 290.75
Interest on Federal Government Bonds	131.25
Interest on Real Estate First Deed of	
Trust Note	60.00
Transfer from Trust Fund Accumulated	
Income Account	16.38

<i>Total Receipts</i>	498.38

	\$ 614.13

DISBURSEMENTS:

Remittance to Virginia Academy of Science—	
Research Fund	267.88

BALANCE—DECEMBER 31, 1953 (Exhibit "A")	\$ 346.25
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CONSISTING OF:

Cash on deposit with Depository Bank of the Trust	
Agent, First and Merchants National Bank of	
Richmond	\$ 346.25

TRUST FUND ACCUMULATED INCOME ACCOUNT --

PRINCIPAL CASH ACCOUNT

STATEMENT OF CASH RECEIPTS AND DISBURSEMENTS
FOR THE PERIOD APRIL 1, 1953, TO DECEMBER 31, 1953

EXHIBIT "F"

BALANCE — APRIL 1, 1953	
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RECEIPTS:

Investment from Virginia Academy of Science —	
Research Fund	\$ 2,000.00

	\$ 2,000.00

DISBURSEMENTS:

Purchase of 55 Shares of El Paso Natural Gas Company Common Stock	\$ 2,000.63
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BALANCE — DECEMBER 31, 1953 (Overdraft)	\$ (.63)
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CONSISTING OF:

Excess payment for stock investment over cash balance by Trust Agent, First and Merchants National Bank of Richmond	\$ (.63)
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TRUST FUND ACCUMULATED INCOME ACCOUNT --**INVESTMENT INCOME CASH ACCOUNT****STATEMENT OF CASH RECEIPTS AND DISBURSEMENTS****FOR THE PERIOD APRIL 1, 1953, TO DECEMBER 31, 1953****EXHIBIT "G"**

BALANCE — APRIL 1, 1953	\$ 16.38
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RECEIPTS:

Dividends on Stock Investments	49.14
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\$ 65.52

DISBURSEMENTS:

Remittances to Virginia Academy of Science --	
Research Fund	\$ 16.38
Transfer to Trust Fund Principal Account	16.38
<i>Total Disbursements</i>	<i>32.76</i>

BALANCE — DECEMBER 31, 1953 (Exhibit "A")	\$ 32.76
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CONSISTING OF:

Cash on Deposit with Depositary Bank of the Trust Agent, First and Merchants National Bank of Richmond	\$ 32.76
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GENERAL FUND**SCHEDULE OF MISCELLANEOUS AND GENERAL EXPENSES
FOR THE PERIOD APRIL 1, 1953, TO DECEMBER 31, 1953****SCHEDULE "1"**

Auditing and Tax Service	\$ 200.00
Expenses of Secretary of the Biology Section	13.75

Expenses of Secretary of the Chemistry Section	6.00
Expenses of Secretary of the Medical Science Section	9.54
Dues to A. A. A. S.	10.00
Post Office Box Rental	30.00
Telephone and Telegraph	6.43
Miscellaneous Expenses	4.02
<i>Total</i> (Exhibit "B")	\$ 279.74

ANALYSIS OF COLLECTION FOR AND REMITTANCES TO
THE VIRGINIA JOURNAL OF SCIENCE
FOR THE PERIOD APRIL 1, 1953, TO DECEMBER 31, 1953

SCHEDULE "2"

BALANCE — APRIL 1, 1953 \$ (321.75)

COLLECTIONS:

Membership Dues at \$2.00 each:	
263 Paid during current period	526.00
10 Delinquent Dues collected	20.00
20 Gratuitous subscriptions to Patrons, Honorary and	
Life Members	40.00
Collegiate Membership at \$1.25 each:	
25 Paid during current period	31.25
(1)	\$ 295.50

REMITTANCES:

April 2, 1953	\$ 10.50
June 5, 1953	78.75
September 11, 1953	29.75
December 17, 1953	8.41
December 18, 1953	1.25
<i>Total Remittances</i> (Exhibit "B")	(2) \$ 128.66

BALANCE — DECEMBER 31, 1953 (1) minus (2) \$ 166.84

REPORT OF THE LONG RANGE PLANNING COMMITTEE

The Committee held no meetings during the past Academy year. It is recommended that the Committee on Science Teaching in the Secondary Schools of Virginia be discharged; this recommendation is made in keeping with the suggestion made by the Chairman of that Committee last year. The original studies assigned the Committee have been completed, but no action on its recommendations has been taken by the Council. The Committee on the Dismal Swamp Project reports progress, but the book on the Swamp has not been completed.

The present Chairman has held this position for five years and has recommended to the President-elect that a new Chairman be appointed.

MARCELLUS H. STOW

REPORT OF THE RESEARCH COMMITTEE

The 1954 J. Shelton Horsley Research Award was won by Dr. Lynn D. Abbott and Miss Mary J. Dodson for their outstanding paper "Inhibition of *in vitro* Heme Synthesis from N¹⁵ Glycine by 2,5-Dimethylbenzimidazole, 5,6-Dimethylbenzimidazole and Related Compounds." The prize winning paper was a contribution from the Biochemistry Laboratories of the Medical College of Virginia. A paper by Mr. J. S. Copenhagen and Dr. W. B. Bell, of the Virginia Polytechnic Institute, entitled "The Production of Bovine Hyperkeratosis (X-Disease) with an Experimentally Made Pellet Feed" received Honorable Mention.

During the year several requests for Research Grants-in-Aid were approved. Persons awarded these grants, with their planned study, and the amount of the grant, follow:

1. Kendall W. King, Biology Department, Virginia Polytechnic Institute. To apply on the purchase of a Bausch and Lomb Monochromatic Colorimeter for a study of "The Isolation and Physiological Characteristics of Cellulolytic Bacteria from the Bovine Rumen" as well as for use with a number of other listed studies of the same department. \$150.00.

2. Jack D. Burke, University of Richmond. Miscellaneous apparatus (Roughton-Scholander Syringe, small animal scales, also animals and food for them) to be purchased to assist in carrying out Oxygen Capacity Studies in Sexual Differences in Mammals". \$150.00.

3. Roger Rageot, Norfolk Museum. For field expenses in studying reptiles and amphibians of the Dismal Swamp. \$200.00.

4. W. H. Lewis, Blandy Experimental Farm, University of Virginia. For field expenses in making a cytotoxicological study of the roses of Virginia (in conjunction with a broader study of the roses of America). \$200.00.

5. John Thornton Wood, University of Virginia Medical School. Expenses while doing bibliographic work at the U. S. National Museum in connection with working up data for publication compiled by the late Roy Ash. The data concerned here deal with the hatching of snapping turtles. \$50.00.

WALTER S. FLORY, JR.

REPORT OF THE FINANCE AND ENDOWMENT COMMITTEE

The Finance and Endowment Committee met on April 14, 1954, and carefully considered the finances of the Virginia Academy of Science. The audit, which had been studied by each member of the Finance Committee, was approved.

It had been recommended by this committee in 1953 that the reserve and other endowment funds be turned over to a consolidated agency account at the First and Merchants National Bank. This has been done and has worked out very well. The suggestion that only about \$500.00 be kept as immediately available cash and the rest being invested has been followed. We feel that this keeps the greatest possible amount of money working for the Academy and not lying idle, but in no way goes against the wishes of the Academy by tying up the funds of the Research Committee.

In the past year this committee has endeavored to find some source of greater revenue for the Academy so that it could take on the finances of the Junior Academy of Science and the Science Talent Search. We feel that this has been partially answered by obtaining business memberships at \$100.00 a year. While only seven or eight of these memberships have been obtained, we hope to increase this to 20 or 25 and urgently request other members of the Academy to help in the promotion of these memberships. We feel that business and industries should be interested in the support of our activities. I am glad to say that the contacts we have made have been most encouraging.

The budget is attached and it will be noted that for the first time the budgets for the Junior Academy of Science and the Science Talent Search are included. On the lower part of the page the budget request by the Junior Academy of Science is shown. The discrepancy between the budget for the Junior Academy for 1954 and that shown in the column above is a difference of \$207.47 which already has been spent by the Junior Academy in the first part of this year. I believe all the other items are self-explanatory.

The estimated income from 900 members is \$3,000. The income from the seven business members is \$700, making a total of \$3,700. We feel certain that we can raise the remaining \$517 from other business memberships which will give us a balanced budget for 1955.

GUY W. HORSLEY

BUDGET
VIRGINIA ACADEMY OF SCIENCE

	<i>Proposed for 1953-1954</i>	<i>Spent to Dec. 31, 1953</i>	<i>Budget 1954</i>	<i>Budget 1955</i>
A.A.A.S. Meeting	\$125.00	\$170.00	\$125.00	\$125.00
Travel expenses for repre-				
sentatives to meetings 200.00	-----	200.00	200.00	
E. C. L. Miller Award 50.00	50.00	50.00	50.00	
Junior Academy of Science				
& Science Talent Search 225.00	371.44	925.47	710.00	
	786.40	800.00	800.00	
Annual meeting expenses 25.00	32.00	30.00	30.00	
Audit and tax services 200.00	200.00	200.00	200.0	
Audit and tax services 200.00	200.00	200.00	200.0	
Premium on fidelity bond 12.50	12.50	12.50	12.50	
Stationery and stenographic				
services 75.00	77.11	75.00	75.00	
Postage 125.00	104.71	125.00	100.00	
Subscriptions to Journal of				
Science for life and				
honorary members 46.00	40.00	40.00	40.00	
Addressograph service 75.00	102.99	75.00	75.00	
Membership subscription to				
Virginia Journal Science				
paid to Journal (\$2 per				
member, 900 members)				
Total 1,158.50	1,947.15	4,457.97	4,217.50	

Junior Academy of Science

Junior Science Bulletin	90.00	200.00
Telephone, postage, etc.	155.00	75.00
Stationery, membership cards, certificates	35.00	35.00
Prizes, promotional activities	163.00	325.00
Speaker for Spring meeting	75.00	75.00
Proposed organizational booklet	200.00	-----

REPORT OF THE COMMITTEE OF THE
VIRGINIA JUNIOR ACADEMY OF SCIENCE

COMMITTEE MEMBERS

Miss Mary E. Humphreys	Miss Vada C. Miller
Franklin D. Kizer	E. Sherman Grable
Miss Susie V. Floyd	Edward R. Dyer
Bruce D. Reynolds	Reuben R. McDaniel
H. Felix Sanders	D. L. Kinnear
	George H. Sands

COMMITTEE MEETINGS

June 13, 1953	Thomas Jefferson Inn	Charlottesville
October 10, 1953	Thomas Jefferson Inn	Charlottesville
February 13, 1954	Thomas Jefferson Inn	Charlottesville

The Virginia Junior Academy of Science as organized for the purpose of promoting and maintaining interest in science among secondary school students. In order to carry out a program for encouraging junior scientists the following activities have been carried out during 1953-1954:

Publicity.--1. The Junior Science Bulletin, a four-page publication, was issued three times during the year and mailed to every science teacher in the state whose mailing address could be obtained. The publication of the Bulletin was made possible by a contribution of \$200.00 by the American Tobacco Company Research Laboratory. The printing has been done by the Newport News High School print shop under the direction of Miss Susie V. Floyd.

2. A picture-story of the Virginia Junior Academy of Science was published in a fall issue of the Virginia Journal of Education.

3. Announcements concerning Virginia Academy of Science work and the Speakers' and Counsellors' Bureau were made at the Science Teachers' Section meeting of the Virginia Educational Association, at each District meeting of the Virginia Educational Association, and at the annual meeting of the Virginia Teachers' Association.

4. Mimeographed letters concerning the Virginia Junior Academy of Science Activities were mailed twice during the year to five-hundred high schools in the State.

Teacher-Sponsor Scholarships.--Summer scholarships of \$200.00 were again made available by the University of Virginia and the College of William and Mary as awards to two outstanding Teacher-Sponsors.

Junior Science Days.--The Committee asked five colleges to sponsor Junior Science Days. Emphasis was to be placed on greater uniformity in competition on exhibits, lectures, tours, etc. These schools did an excellent job. A total of 136 student exhibits were on display at the Junior Science Days; 46 individual and 10 club exhibits were qualified for entry at the May meeting of the Virginia Junior Academy of Science.

Affiliation of Clubs and Individual Memberships.--Seventy-two clubs are directly affiliated with the Virginia Junior Academy of Science; fifty-two clubs affiliated through Science Clubs of America; there are 2,563 individual memberships.

Program for May Meeting.--To make the Annual Meeting of the Virginia Junior Academy of Science of more significance to the Juniors, the following plans were made and accomplished.

1. Exhibits were left up longer to allow a longer time for better judging, and to allow Senior Members to see all of them.
2. Students were selected and were escorted by Senior scientists during a part of the day on May 7. The Senior scientists who were "buddies" with the students gave them excellent advice on their scientific careers, introduced them to the Section Meetings of the Academy, joined them during the Junior-Senior Science Hour to see the projects of the students and to see the presentation of the awards.
3. A guest speaker, Dr. Carroll M. Williams, Professor of Zoology of Harvard University, gave a very inspirational talk on the subject: "Brains and Silken Chambers."

Awards

The following awards are made by the Virginia Junior Academy of Science:

1. E. C. L. Miller Award--Woodberry Forest Science Club, Woodberry Forest, "Mouse Project"--Sponsor, Mr. John Catt
2. Major Catesby Jones Award made to the project having greatest research significance--Jane Black, James Monroe High School, Fredericksburg, "Electrostatic Separation of Titanium from Sediment"
3. Club Exhibits
 - First Place--Woodberry Forest Science Club, Woodberry Forest, Mr. John Catt, Sponsor, "Mouse Project"
 - Second Place--Armstrong High School Mathematics Club, Richmond, Miss Beatrice Harrington, Sponsor -- "Mathematical Models and Graphs"
 - Third Place--Booker T. Washington Science Club, Norfolk, Mr. John Perry, Sponsor--"Miscellaneous"
 - Honorable Mention--Newport News Science Club, Newport News, Miss Susie V. Floyd, Sponsor--"Tree of Science".
4. Individual Exhibits
 - First Place--Larry Johnson, Woodrow Wilson High School, Portsmouth--"Adrenalin Reaction"
 - Second Place--Doris Hermes, Martinsville High School, Martinsville, --"Discharge Printing on Dacron"
 - Third Place--Walter Thomas, Kempsville High School, Norfolk -- "Wind Tunnel"

Honorable Mentions:

Emma Lou Marchant, Mathews High School, Mathews
Carolyn Evans, Martinsville High School, Martinsville
Floyd Wilson, Booker T. Washington High School, Norfolk
Allen Reynolds, Wilson Memorial High School, Fishersville
Joanna Hackman, Radford High School, Radford
Jane Black, James Monroe High School, Fredericksburg.

5. Honorary Membership in American Association for the Advancement of Science:

Eleanor O'Meara, Lane H. S., Charlottesville
Floyd Wilson, Booker T. Washington H. S., Norfolk.

6. Honorary Membership in the Virginia Academy of Science:

Allen Reynolds, Wilson Memorial High School, Fishersville
Frank Chilton, Washington-Lee H. S., Arlington.

7. Teacher-Sponsor Scholarships:

University of Virginia—Miss Delores Hoback, Martinsville H. S.
Alternate—Mr. A. B. Niemeier, Craddock H. S.

College of William and Mary—Mr. John Catt, Woodberry Forest
High School.

Alternate—Miss Leslie Watkins, Andrew Lewis H. S., Salem.

The Chairman expresses sincere appreciation to Miss Floyd and the Newport News High School for the excellent work on the publication of the JUNIOR SCIENCE BULLETIN, and to the officers of the Academy and the members of this Committee for their advice and willing and able participation in the Committee's work ,and to the Senior Scientists who co-operated so whole-heartedly in the Junior-Senior "buddy" program.

MRS. B. G. HEATWOLE

REPORT OF**THE NINTH VIRGINIA SCIENCE TALENT SEARCH**

The Virginia Science Talent Search is an activity of the Virginia Academy of Science that has as its objective the encouragement of talented secondary school students who are interested in science to continue their studies in college. Virginia Colleges and Universities cooperate in this program by giving special consideration to successful competitors in the Search when they award their scholarships.

The Virginia Search is limited to those secondary school seniors who the previous December have entered the National Science Talent Search, conducted by Science Clubs of America, Washington, D. C., for the Westinghouse Foundation. This year (1953-54) 105 students from 32 Virginia high schools submitted entries, consisting of (1) a science aptitude and information test, (2) high school scholastic record, (3) biographical data and questionnaire filled out by the teacher-sponsor, and (4) a brief essay or report on a scientific project, activity, or subject. The number of entries is somewhat smaller than last year, in spite of the fact that

an effort was made to publicize the Search in November by mailing two bulletins to all schools and individual teachers where known, calling their attention to the Search and the scholarship program.

In March, after the entry papers were received from the Science Clubs of America, the marks on items (1) and (2) above were tabulated, biographical data and questionnaires were evaluated by members of the Committee, and the essays were read by members of the University of Virginia Science Faculties. On the basis of these entries 45 finalists (including the four National Honorable Mentions) were selected and invited with their sponsors to attend the Annual Meeting of the Academy. Forty-three finalists and 18 sponsors were able to attend, and the Academy reimbursed their travelling expenses to the amount of four cents per mile.

At the meeting, finalists were interviewed by four three-man panels composed of members of the Committee and scientists invited from the faculties of Virginia Colleges and Universities. The results of these interviews were combined with the written records to pick fifteen Winners, the other thirty finalists automatically gaining Honorable Mention.

WINNERS

**These students won National Honorable Mention.*

- Herbert S. Bennett, Washington-Lee H. S., Arlington
- Jane R. Howard Black, James Monroe H. S., Fredericksburg
- Robert N. Bolster, Washington-Lee H. S., Arlington
- Edward A. Branch, Craddock H. S., Portsmouth
- *Frank McG. Chilton, Washington-Lee H. S., Arlington
- Richard L. Hartman, Maury H. S., Norfolk
- *Doris Jean Hermes, Martinsville H. S., Martinsville
- Robert E. Jordan III, Halifax County H. S., South Boston
- Ronald G. Kinzie, Wilson Memorial H. S., Fishersville
- Michael W. Konrad, Washington-Lee H. S., Arlington
- James V. Mageean, Norview H. S., Norfolk
- Arthur D. Old, Maury H. S., Norfolk
- *Eleanor W. O'Meara, Lane H. S., Charlottesville
- Allen H. Reynolds, Wilson Memorial H. S., Fishersville
- *Floyd Wilson, Booker T. Washington H. S., Norfolk.

HONORABLE MENTION

- Harman W. Agnew, Jr., Floyd H. S., Floyd
- Donnie C. Bendall, John Marshall H. S., Richmond
- Margaret L. Bowes, Huntington H. S., Newport News
- Robert Lee Brand, Robert E. Lee H. S., Staunton
- James P. Charlton, Buckingham Central H. S., Buckingham
- Horace Eldridge Curlis, Jr., John Marshall H. S., Richmond
- Carolyn S. Evans, Martinsville H. S., Martinsville
- Edvin V. Farinholt, Lane H. S., Charlottesville

Norma Ellen Halmagyi, Thos. Jefferson H. S., Richmond
 Richard F. Harrington, Granby H. S., Norfolk
 Diane E. Harris, Armstrong H. S., Richmond
 Henry H. Harris, Jr., Lane H. S., Charlottesville
 David E. Haught, Culpeper H. S., Culpeper
 Edward S. Jones, Carter G. Woodson H. S., Hopewell
 Michael F. Kavanaugh, Jefferson Senior H. S., Roanoke
 Margaret J. Lilly, Dublin H. S., Dublin
 Robert C. Lyne, Jr., Thos. Jefferson H. S., Richmond
 Barbara Anne Miller, Thos. Jefferson H. S., Richmond
 Jesse H. Motes, Washington-Lee H. S., Arlington
 Lillie Mae Parker, Southampton County Tr. Sch., Courtland
 Richard B. Perry, Jefferson Senior H. S., Roanoke
 Robert C. Richardson, Washington-Lee H. S., Arlington
 Florence E. Robey, Andrew Lewis H. S., Salem
 John A. Rosado, Washington-Lee H. S., Arlington
 Furman L. Sheppard, Jr., Norview H. S., Norfolk
 Edwin Lee Showalter, Jefferson Senior H. S., Roanoke
 Richard H. Skeppstrom, Woodrow Wilson H. S., Portsmouth
 William D. Vick, John Marshall H. S., Richmond
 James A. Weinstein, Washington-Lee H. S., Arlington
 Edward Wiles, Jr., John Marshall H. S., Richmond.

The names of these students have been sent with the endorsement of the Virginia Academy of Science to all Virginia Colleges and Universities and to all out-of-state institutions where the students are known to have applied for admission or financial aid.

The Chairman is happy to have this opportunity to make the following grateful acknowledgments: to President Gwathmey for encouragement and advice as well as the use of his office staff and facilities; to the presidents and officers of Virginia colleges and universities for their interest in the scholarship program; and to the Committee members and guest judges for their cheerful help.

EDWARD R. DYER, JR.

REPORT OF THE MEMBERSHIP COMMITTEE

As of March 15, 1954, the membership of the Academy was made up as follows:

Regular members	767
Business members	5
Contributing members	67
Sustaining members	27
Life or honorary members	18
Patrons	3
Student members	48
Total.....	935

All members in arrears in dues for more than one year had been dropped from membership shortly after the first of the year.

During the period, May 1 — December 31, 1953, new members were obtained as follows:

Regular members	42
Contributing members	1
Student members	13
Total.....	56

HENRY LEIDHEISER, JR.

JAMES RIVER PROJECT

The sale of the monograph on "The James River Basin — Past, Present, and Future" continues to be steady though certainly not lively. During the past year, copies have been bought by libraries, both domestic and foreign, by individuals and by bookdealers. Herewith is the financial statement for the year 1953-54.

SUMMARY AS OF MAY 5, 1954

Total copies distributed as of April 30, 1953	511
Balance on deposit, Peoples National Bank, Lexington, Va., as of April 30, 1953	\$1,657.90
Complimentary copies distributed between May 1, 1953, and May 5, 1954	3
Copies sold, payment received at \$6.00, between May 1, 1953, and May 5, 1954 — 16 copies	\$ 96.00
Copies sold, payment due, between May 1, 1953, and May 5, 1954	0
Total copies distributed between May 1, 1953, and May 5, 1954	19
Total cash received between May 1, 1953, and May 5, 1954	\$ 96.00
Deposited in bank between May 1, 1953, and May 5, 1954	\$ 96.00
Expenditures charged to Monograph account between May 1, 1953, and May 5, 1954	\$ 0.00
Net balance in Peoples National Bank from sales May 1, 1953, and May 5, 1954	\$ 96.00
Total balance in Peoples National Bank from sales May 11, 1950, to May 5, 1954	\$1,753.90
Total copies distributed May 11, 1950, to May 5, 1954	530

MARCELLUS H. STOW

REPORT OF COMMITTEE ON RESOURCE USE EDUCATION, VIRGINIA ACADEMY OF SCIENCE

Interest in resource use education matters in Virginia has remained active during the past year, even increased in certain phases, as adjudged by those engaged in conservation education extension work.

The Governor's office set aside two separate periods during the year for the focusing of attention on conservation: *Conservation Week* set aside in October, and *Wildlife Restoration Week* in March.

The Commission of Game and Inland Fisheries reports that interest in the conservation essay contest is growing yearly and that in the seven years that the project has been held in the schools, more than 75,000 young people have been taught grass-roots conservation as a result. Resource use education has also been stressed by other state resource agencies, particularly the Commission of Fisheries, Virginia Forest Service, State Water Control Board, Virginia Extension Service, and others.

Several summer workshops in resource use were held in the State. Radford State Teacher's College had a two-week course for teachers in July. At the Virginia Fisheries Laboratory a one-week course in seafood conservation was given a group of agricultural teachers in July.

Interest in two other teachers workshops was indicated, namely at Richmond Professional Institute and at Bridgewater College, but because of too few students the workshops were not held.

Many of the Committee's members played an active role in the deliberations of the Virginia Resource Use Education Council, which met twice during the year, and whose broad objectives closely parallel those of the Committee.

One Committee meeting was held during the year, with the group assembling in Richmond on March 29. Those in attendance were: Elizabeth Perry, J. W. O'Byrne, William C. Kellner, Max Carpenter, Ross H. Walker, T. V. Downing, R. A. Bailey, Harry M. Jopson, E. W. Mundie, D. S. Wallace, and J. J. Shomon.

At this meeting the broad objectives of the Committee were reviewed and reaffirmed. A sub-committee was appointed to meet with the State Superintendent of Public Instruction to aid in accomplishing the objectives of the Committee (see 1952 and 1953 Committee reports.)

The group also gave its endorsement to the Game Commission's essay contest, urged more conservation symposia at different meetings throughout the State, and lent its support to a move to establish a creditable Museum of Natural History for the Commonwealth.

The chairman wishes to express deep appreciation for the cooperation received from the officers of the Academy and the members of the Resource Use Education Committee. What progress has been made by the Committee has come as the result of this very fine and generous assistance.

J. J. SHOMON

REPORT OF THE COMMITTEE ON VIRGINIA FLORA

Efforts to have a meeting of the committee during the year have not been successful, the members of the committee being widely scattered. Members of the committee have been active in publications and field work. Dr. Paul M. Patterson continues to be especially active in field work and publications relative to the mosses of the State. Some progress has been made in the development of an annotated check list giving data on distribution and ecology of the species. This is to be continued with the hopes of early completion. The new edition of Gray's Manual being expensive and the Key unsatisfactory for students' use, it presents a challenge to the committee to push its work towards the development of a State flora.

Members of the committee have given illustrated lectures relative to native plants and conservation.

A. B. MASSEY

REPORT OF THE SPEAKERS AND COUNSELORS COMMITTEE

This committee operated on a very limited basis in keeping with the suggestion of the President of the Academy.

Members of the science faculties of Bridgewater College, Eastern Mennonite College, and Madison College participated in the work of the Committee. Talks and demonstrations were made to a number of high school assemblies, science clubs, and science classes. The geographical area covered extended from Arlington County to Augusta County.

The groups who have been served by the Speakers and Counsellors Committee have been most appreciative and have said that the speakers who visited them have done much to stimulate interest in science.

It is believed that this Committee can do a tremendous amount of good in disseminating scientific information and in evoking interest in science. It should be continued if possible. It should, however, be mentioned that it is often difficult for faculty members to leave their institutional responsibilities in order to speak to school groups and other organizations. Also the matter of transportation is frequently a problem. In making the decision concerning the future of this Committee the matter of the availability of speakers should receive primary consideration. The desire on the part of the schools to have the speakers has been quite evident to the Chairman of this Committee.

PERCY H. WARREN

REPORT OF THE COMMITTEE ON RESOLUTIONS

1. BE IT RESOLVED, that the Virginia Academy of Science express its thanks to the Committee on Resolutions wishes to present the following resolutions for your approval.

grateful appreciation to its host, the University of Virginia, and to its President, Colgate W. Darden, Jr., for its gracious hospitality.

2. BE IT FURTHER RESOLVED, that members of the Local Committee on Arrangements, under the chairmanship of Dr. Frederick W. Young, and all other University personnel who assisted, be commended for the excellence of their many contributions to the success of this Thirty-Second Annual Meeting of the Virginia Academy of Science.

3. BE IT FURTHER RESOLVED, that the Virginia Academy of Science commend the staff of the Virginia Journal of Science for the outstanding work performed.

4. BE IT FURTHER RESOLVED, that the Virginia Academy of Science recognize the interest and contributions of its members, particularly Mrs. B. G. Heatwole and Dr. Edward N. Dyer, to making the junior science program so effective.

5. BE IT FURTHER RESOLVED, that the Virginia Academy of Science express its gratitude for past services and record its tribute to the esteemed members who have been lost by death during the past year.

Dr. Roy Philip Ash

Dr. H. B. Derr

Dr. Fred A. Dove

Dr. Carroll Cephas Flora

Dr. Douglas Southall Freeman

Dr. A. W. Hurd

Dr. John Lloyd Newcomb

Dr. M. Pierce Rucker

Dr. James Henderson Smith

WILLIAM E. TROUT, JR.

REPORT OF THE VIRGINIA INSTITUTE OF SCIENTIFIC RESEARCH

The Research Institute is now in its fifth year, and it is believed that the most significant contribution of the past year has been the publication of three papers by Dr. Leidheiser and his group working in the field of metal surfaces. Two were in the Journal of the Electrochemical Society and one in the Journal of Chemical Physics. A fourth paper is now in preparation. Dr. Leidheiser has also recently been invited to present a paper to a special conference in England in the field of electrochemistry.

The calibre of any scientific institution must ultimately be evaluated by its contribution to scientific knowledge, and it is now gratifying that the efforts of all those who have supported the Institute — especially those actually engaged in the research — are now bearing fruit.

It will be remembered that the ultracentrifuge and the electron microscope were put into operation in 1952. These are highly specialized instruments, and it is fair to say that during the past year, Dr. Likes has

become an experienced researcher with the centrifuge and Mr. von Gemin-gen with the electron microscope. During the past year, Mr. von Gemin-gen attended a brief course on electron microscopy at Cornell. Interesting and surprising results are now being obtained with both of these instruments. An electrophoresis unit for the determination of molecular weights and a thermal diffusion unit for the separation of molecules of different sizes and shapes have been recently purchased with the aid of a gift from the E. M. Todd and Company of Richmond.

Several new studies were begun during the year: one on the deter-mination with the ultracentrifuge of the cholesterol content of blood of patients suffering with coronary and diabetic diseases. Interesting studies were initiated by Dr. Krug on the growth of organic crystals in the hope of using these crystals for a better understanding of the mechanism of organic reactions. It is hoped in the near future to continue preliminary studies made about a year ago on the molecular weight of protein mole-cules in tobacco.

At the present time, there are nine members of the permanent staff and seven part-time workers. The total income for the year was \$84,916.00.

The staff of the Institute would be very pleased to have members of the Academy visit the Laboratory at any time.

ALLAN T. GWATHMEY

**FINANCIAL STATEMENT
VIRGINIA JOURNAL OF SCIENCE
VIRGINIA POLYTECHNIC INSTITUTE
STUDENT ACTIVITIES OFFICE
OPERATION STATEMENT FOR THE FISCAL YEAR
Virginia Journal of Science
April 10, 1953, to May 3, 1954**

Receipts:

Academy Subsidy	
Regular members 951 at \$2.00	\$ 1,902.00
Student members 66 at \$1.25	82.25
Advertising	518.80
Subscriptions	502.02
Extra pages	55.48
Miscellaneous	7.00

TOTAL OF ALL RECEIPTS	\$ 3,067.55

Reprints	\$ 210.50
Printing of Journal	2,263.40
Postage	153.12
Engraving	121.80
Office Supplies	57.00
Miscellaneous	33.20
Printing of Index	39.00
Composition of Article	105.85

TOTAL OF ALL EXPENDITURES	\$ 2,983.87
NET AMOUNT	83.68

STATEMENT OF CASH ACCOUNT

Balance of cash at beginning of year	\$ 3,160.57
Total receipts for year	3,067.55
Total cash on hand during year	6,228.12
Total expenditures for year	2,983.87

Balance of cash at end of year	\$ 3,244.25

Audited by: Joe W. Guthridge

Date: May 5, 1954

VIRGINIA JOURNAL OF SCIENCE
STATEMENT OF ACCOUNTS RECEIVABLE

May 5, 1954

Monroe Calculating Machine Company	\$ 17.50
January 1953 issue	
Eastern Advertising Agency	
September 1953 issue	\$.50
January 1954 issue	24.90
April 1954 issue	24.90
50.30	9.80
Merchant Calculator	
April 1954 issue	
Cardinal Products	
April 1954 issue	
Dombrower Advertising Agency	
April 1954 issue	

	\$131.90

Audited by: Joe W. Guthridge

Date: May 5, 1954

MINUTES OF SECTION OF AGRICULTURAL SCIENCE [1]

H. MARSHALL CLARK, *Chairman*

RODNEY C. BERRY, *Vice-Chairman*

R. W. ENGEL, *Secretary*

WESLEY P. JUDKINS, *Section Editor (1956)*

FRIDAY, MAY 7, 1954 — 9:00 A.M. — ROOM 118, CABELL HALL

1. THE RELATIONSHIP OF BROWSE TO DEER WEIGHTS IN BATH COUNTY, VIRGINIA.

R. J. Muncy; *Virginia Cooperative Wildlife Research Unit, Blacksburg.*

Studies of white-tailed deer herd conditions throughout the Commonwealth of Virginia have been initiated as the basis of future deer management. The deer herd in Bath County, Virginia, was believed to be out of balance with its habitat; therefore, detailed range and deer population data were desired.

Samples of the 1953 deer kill for Bath County were classified into two groups based on determined differences in populations of the two regions from which they were obtained. A significant difference was obtained between the average weights and body measurements of deer from the two regions in 8 of 15 tests, and a very significant difference was obtained in 6 of the 15 tests. Range conditions indicated that the higher populated area, with smaller deer body sizes, had less available browse and lower quality browse species present. Browse utilization studies indicated greater browse utilization in the higher deer population area. All phases of this investigation indicate that a high deer population depletes the vegetation both as to quantity and quality, and that this influence of the deer upon the vegetation is reflected to a measurable degree by body sizes of the deer from those ranges.

2. ECOLOGICAL SUCCESSION ON ABANDONED FARMLAND IN CUMBERLAND COUNTY, VIRGINIA — ITS RELATIONSHIP TO WILDLIFE MANAGEMENT.

Mitchell A. Byrd; *Virginia Cooperative Wildlife Research Unit, Blacksburg.*

The problem of land abandonment in Virginia has reached considerable magnitude in the past thirty years. At present, there are approximately two and one half million acres of this idle land within the boundaries of the State. The natural habitats on these lands are in a constant state of flux, as they are undergoing a series of slow but well defined stages.

This study was an analysis of some of the changes which take place in wildlife habitat on abandoned cropland fields over a period of years

and the effects of these changes on the general population of cottontail rabbits and bobwhite quail. The principal objective of the study was the determination of the trend of natural plant succession on abandoned cropland fields in the Piedmont Region of Virginia and the interpretation of this information in terms of practical wildlife management. If these successional data are accurately analyzed, they may indicate in general what has happened, is happening, or may be expected to happen on much of the approximately two and one half million acres of abandoned land in the State of Virginia.

3. RABIES IN VIRGINIA AND ITS ECONOMIC EFFECT ON AGRICULTURE.

John C. Jones; *Fish and Wildlife Service, Department of Interior, Richmond.*

Rabies is an old disease but our knowledge of it is still inadequate. Usually it is thought of only in terms of dogs. The connection between its presence in wildlife and losses in livestock receives little attention and is poorly understood. Over the past two years, it is conservatively estimated that in Virginia losses in livestock must total more than a million dollars. Foxes may play an important part in the spread of rabies.

It is difficult to discuss rabies in terms of an epidemic. To the public the term connotes great numbers of cases. Yet, the actual presence of a few proven cases is a very real danger signal.

A comprehensive control program includes vaccination of pets, rounding up of all stray dogs and cats, and reduction of the fox population. These should be started promptly upon detection of the disease, and should be accomplished within a 3-month period. A 75 percent coverage of each phase should be the minimum objective.

With reference to the foxes, the target is the disease, not the animal. The resulting healthy stock is a far greater contribution to conservation than allowing a poor and disease-ridden population to exist.

4. THE PRODUCTION OF BOVINE HYPERKERATOSIS (X-DISEASE) WITH AN EXPERIMENTALLY MADE PELLET FEED.

Jack S. Copenhaver and Wilson B. Bell; *Virginia Agricultural Experiment Station, Blacksburg.*

Calves fed pellets made when the pellet mill was lubricated with a lubricant that did not contain highly chlorinated naphthalenes did not develop symptoms and lesions of bovine hyperkeratosis. Calves fed pellets made when the pellet mill was lubricated with a lubricant containing highly chlorinated naphthalenes developed symptoms and lesions of bovine hyperkeratosis.

5. RUMEN INOCULATION IN BEEF CALVES.

F. S. McClaugherty and C. M. Kincaid; *Virginia Polytechnic Institute, Blacksburg.*

Twenty-four steer calves, approximately three to four months of age

from one herd of cattle and sired by one bull, were fed to determine the effect of artificial rumen cultures and direct rumen withdrawals on the rate of gain and efficiency of feed consumption by calves. In the first phase of the experiment, there were two replicates with four treatments each: (A) Culture made from material taken from the rumen of a fast-gaining steer at slaughter, (B) culture made from material taken from the rumen of a slow-gaining steer, (C) a commercial rumen culture, and (D) control. The feeding tests showed that the differences in rate of gain and also in feed consumption were no larger than would be expected due to chance alone.

6. PERFORMANCE TESTING OF BEEF CATTLE ON THE FARM.

J. E. Grizzle, C. M. Kincaid, and Curtis Mast; *Virginia Polytechnic Institute, Blacksburg.*

In cooperation with the Virginia Aberdeen Angus Breeders Association, the Experiment Station and Extension Service of the Virginia Polytechnic Institute started a program in January, 1953, to test the feasibility of measuring performance of beef cattle on the farm of the breeder. A total of 353 calves in 12 herds owned by nine breeders were weighed, graded, and indexed. All calves born during the year in each herd were included in the work. Indexes based on weight for age and type score were computed for each calf at six and 12 months of age. The herds were scattered over seven different counties, and each herd was visited three times. It was concluded from this pilot work that this kind of program for beef cattle breeders could be achieved, and it was expanded to include breeders of the three major breeds of beef cattle. On May 1, 1954, there were enrolled in the Virginia Beef Cattle Record of Performance 34 breeders with over 625 calves.

7. VARIATIONS IN THE LENGTH OF GESTATION PERIODS IN DAIRY CATTLE.

Paul M. Reaves, *Virginia Polytechnic Institute, Blacksburg.*

The length of the gestation period in dairy cattle has been reported to vary from 276.2 to 290.9 days. The range has varied from below 245 days to 305 days.

Factors influencing the length of the gestation period include: breed, sex, multiple births, sires, cow families, age of dam, and season of the year.

A study was made of 685 gestations culminating in normal calvings over a 6-year period for the 3 breeds in the Virginia Polytechnic Institute herd. The average length of gestation periods was 278.3 days for Jerseys, 279.9 for Holsteins, and 285.7 days for Guernseys.

Variations in length of time according to the sex of the calf showed that the male calves were carried longer than the heifer calves.

Twin calves occurred in 2.5 per cent of the time. Twins were carried 5 to 7 days less than single calves.

The seasonal influence was variable.

Calves sired by different sires were carried on the average for different lengths of time.

8. SUBSTITUTION RELATIONSHIPS BETWEEN GRAIN AND FORAGE IN MILK PRODUCTION.

Carl W. Allen; *Virginia Agricultural Experiment Station, Blacksburg.*

Knowledge of how one feed will take the place of another in the ration is important in determining the least cost combination. Considering the cow's inherent ability to produce milk and her capacity for different feeds, the substitution ratio between the feeds must be equal to the price ratio (inverse) for a minimum cost ration.

Using comparable feed and production records from six State Experiment Stations, several functional relationships between inherent ability, feed inputs, and milk output have been studied through regression techniques. They all show rather conclusively that forage (or grain) substitutes at a diminishing marginal rate for grain (or forage) in producing a given output of milk. For the given output of milk, as more and more forage (or grain) is included in the ration, each successive pound of additional forage (or grain) takes the place of less and less grain (or forage.) Also, these regression equations (production functions) indicate that these substitution relationships between grain and forage change in going to a higher level of output from a cow of given inherent ability. Forage is worth less and less in terms of grain with increased production from the cow of given inherent ability.

9. CORRELATION BETWEEN BLOOD LEVELS OF CAROTENE AND VITAMIN E IN DAIRY COWS IN SELECTED HERDS IN VIRGINIA.

W. N. Linkous, N. O. Price, W. B. Bell, W. A. Hardison, and R. W. Engel; *Virginia Agricultural Experiment Station cooperating with the Virginia Artificial Breeders' Association.*

In an experiment designed to establish whether or not the nutritional status of dairy cattle, as measured by nutrient blood levels, could be related to their breeding efficiency, analyses were conducted on blood plasma for carotene and tocopherols at three-month intervals between July, 1953, and February, 1954. Seasonal changes in the blood levels of these nutrients were observed. In July and October, 1953, when the herds had access to fresh forage their carotene concentration was high compared to the values observed in February, 1954, when the feed consisted of conventional winter rations of hay, silage, and concentrate. Observations on a total of 45 Guernsey dairy cows at the three seasons (summer, fall, and winter) revealed a significant positive correlation between blood-circulating carotene and tocopherols ($r = .568$). In 70 Holstein cows the positive correlation between levels of these nutrients in plasma were likewise significant ($r = .586$). It is believed that these correlations reflect the nutrient intake level and that the level of feed tocopherol declines with decline in quality of roughage as is well known to occur with carotene.

10. PROBLEMS IN THE CORRELATION OF SOIL TESTS WITH CROP RESPONSE IN VIRGINIA.

Russell K. Stivers and C. I. Rich; *Virginia Agricultural Experiment Station*, Blacksburg.

Rapid soil test results for available phosphate and potash, and crop response data to phosphate and potash fertilization on two different experimental fields in Virginia are reported. Some of the soil test data were closely correlated with crop response while others were not. Such difficulties have been reported by workers in other states. They may be related to differences in feeding ability of different crops, failure to thoroughly characterize the soil, differences in climate, or differences in time of sampling.

Peanut plant chemical composition data were presented with soil test results from the areas on which the peanuts were growing. Increasing amounts of available potassium in the soil were shown to be associated with a decreasing percentage of calcium and an increasing percentage of potassium in the peanut leaves. The available calcium in the soil, however, showed no relation to the percentage of calcium in the peanut leaves. These relationships show that correlation of soil tests with crop response is intimately tied to problems in plant nutrition.

11. STUDIES OF THE PARASITISM OF *Cercospora arachidicola* Hori AND *Cercospora personata* (B. AND C.) ELL. AND EV.

Lawrence I. Miller; *Virginia Agricultural Experiment Station*, Holland.

A peanut leafspot survey made in ten Southern States indicated that *Cercospora arachidicola* was more prevalent than *Cercospora personata*. It was found that the two *Cercospora* species are composed of countless biotypes which are similar morphologically, but which may be distinguished by their cultural characteristics and their differences in pathogenicity. Since mutation does occur in culture, it is probable that it plays a role in the formation of new biotypes. The studies made of several races of the two species of *Cercospora* indicate that races of *C. arachidicola* form conidia, infect, allow lesion development, and cause leaf shedding over a wider range of temperatures and at a higher temperature optimum than do races of *C. personata*. It was found that under certain conditions nodulation, plant nutrients, and injury of insects and nematode pests affect the relative resistance rating of the plants to leafspot. Conditions which promoted early maturity generally increased the relative susceptibility rating, while conditions which delayed maturity resulted in a relatively higher resistance rating. Generally, resistance to the leafspot disease allows a plant to grow longer, because the intensity of the disease is not great enough to cause premature ripening.

12. WEATHER INFLUENCES ON EVAPORATION.

J. M. Johnson; *Virginia Agricultural Experiment Station*, Blacksburg.

The influences of air temperature, relative humidity, wind velocity, and sun intensity on evaporation rates were studied in relation to potato harvest.

Sun intensity was measured by the elevation above air temperature of a white painted tube of a soil thermograph exposed directly to the sun. The effect of all factors was measured by recording the distilled water evaporated from a Livingston white globe, porous porcelain atmometer bulb.

Air temperature and relative humidity were combined by use of hygroscopic tables into one factor, vapor pressure deficit.

Vapor pressure deficit was most closely associated with evaporation rates, explaining 48 of the 77 percent of the variation in evaporation rates explained by all factors. Wind velocity was next most important, explaining 18 percent; and sun intensity explained 11 percent.

The regression equation resulting from the linear multiple correlation analysis was:

$$X_1 = 2.527737 + (.257644 \pm .018652) X_2 + (.166346 \pm .024781) X_3 \\ + (.440121 \pm .024889) X_4$$

in which:

X_1 = Evaporation in three hours (cc., H₂O)

X_2 = Miles of wind in three hours

X_3 = Sun intensity (Soil tube temperature minus air temperature)

X_4 = Vapor pressure deficit (mbhg)

The rank of importance of the individual factors in influencing variation in evaporation was in general the same as for all areas combined.

13. THE IMPORTANCE OF WEEDS AND THEIR CONTROL IN TODAY'S AGRICULTURE.

W. E. Chapell, Plant Physiologist; *Virginia Agricultural Experiment Station*, Blacksburg.

Annual losses to farmers in the United States due to weeds are estimated at \$5,000,000,000; a figure higher than combined insect and disease losses. Weed losses include (1) increased cultivation costs, (2) lowered crop yields due to direct competition for water, light, and nutrients, (3) lowered quality of crops due to presence of weed seeds and other debris in certain crops, and (4) acting as hosts for many crop insects and diseases.

Control of weeds in crops by the use of herbicides was practically nonexistent prior to 1944 when the selective weed-killing ability of 2, 4-D was discovered. Since this discovery, thousands of new compounds have been synthesized and tested on weeds and crop plants. Herbicides are divided into those that kill plants on contact and those that kill by disrupting the normal metabolic activity as they are translocated throughout the plant. In each of these groups are chemicals that will selectively kill

weeds in certain crops. This selectivity is based on physical and chemical composition of the herbicide, the physical and chemical make-up of crops and weeds, stage of development of crop plants and weeds, dosage level, timing and placement of the application, or a combination of any of these factors.

14. THE BROMIDE CONTENT OF THE PEANUT PLANTS FROM SOIL TREATED WITH ETHYLENE DIBROMIDE FOR STING NEMATODE CONTROL.

R. W. Young, L. I. Miller, and R. W. Engel; *Virginia Agricultural Experiment Station*, Blacksburg.

Ethylene dibromide, applied broadcast at the rate of 21 pounds per acre with a shank applicator at a 6-inch depth, will effectively control the sting nematode (*Belonolaimus gracilis Steiner*) and correct the stunted plant disorder. Yields of better quality nuts and hay are profitably increased by controlling the sting nematode. The bromide content of peanut kernels grown in fumigated soil is not significantly increased. No adverse flavor was imparted to kernels. Cured hay from untreated plots ranged from 40 to 90 ppm. total bromide; from fumigated plots 139 to 146 ppm. total bromide. Peanut plants readily absorb bromide ions, and the bromide content of soil from areas fumigated with ethylene dibromide (21 to 35 lb. rate) may be lower than that of untreated areas at the end of the growing season. The more prolific root systems of plants in fumigated soil may absorb more bromide than the stunted roots of plants in untreated, sting nematode infested soil. The increase of bromide in peanut hay from treated areas is not expected to have a harmful effect when consumed by farm animals. A study is in progress, however, to evaluate the effect of feeding the hay from treated areas to cows.

15. NATURE OF INSECT RESISTANCE TO CHEMICAL POISONS.

James McD. Grayson; *Virginia Agricultural Experiment Station*, Blacksburg.

Insect resistance to chemical poisons has become an increasingly important problem during the past forty-five years. An analysis of this problem reveals a complex of independent and interesting factors which rather logically can be grouped as follows: physiological, genetical, and behavioristic. The so-called "resistance" of the California red scale to HCN, and the codling moth to lead arsenate, are apparently attributable to factors other than actual tolerance to the chemical poisons involved. True tolerance to DDT in many insect species is attained through some detoxification process, the details of which are not fully known.

16. AN IMPROVED PROCEDURE FOR THE DIRECT ISOLATION OF CELLULOYTIC RUMEN BACTERIA.

Paul H. Smith and K. W. King; *Virginia Polytechnic Institute*, Blacksburg.

Direct isolation of cellulolytic rumen bacteria may be achieved by modifying the procedures which Huhtanen and Gall (1952) proposed for rumen

bacteria in general. The rumen fluid supplement has been refined. Cellulose decomposing bacteria are detectable by clear zones surrounding their colonies when water-insoluble cellulodextrins are incorporated in the medium. Preliminary observations on some of the isolates from the Virginia Polytechnic Institute herds as well as data indicating the usefulness of the modified procedure are included.

17. REFINEMENTS IN PLATE COUNTING PROCEDURES FOR CELLULOSE DECOMPOSING SOIL MICROORGANISMS.

J. D. Castro and K. W. King; *Virginia Polytechnic Institute, Blacksburg.*

Media used for both isolation and plate counts of cellulolytic soil microorganisms up to now have contained only ammonia or nitrate as nitrogen sources. Consequently organisms possessing even a single nutritional requirement for organic nitrogen have not been detected. Established procedures for obtaining plate counts of cellulolytic soil bacteria have been modified by (1) inclusion of organic nitrogen, (2) revision of the procedure for preparation of water-insoluble cellulodextrin, and (3) addition of sparkling amounts of cellobiose to the medium. Data indicating the enhanced sensitivity of the new medium are presented.

BUSINESS MEETING

The annual business meeting was held at the close of the scientific session. The following were elected to serve as officers of the section for the 1954-55 period:

Chairman—Rodney C. Berry, Director and State Chemist, Department of Agriculture and Immigration, Richmond.

Vice-Chairman—R. W. Engel, Department of Biochemistry and Nutrition, Virginia Polytechnic Institute, Blacksburg.

Secretary—Paul M. Reaves, Department of Dairy Husbandry, Virginia Polytechnic Institute, Blacksburg.

Section Editor—Wesley P. Judkins, Department of Horticulture, Virginia Polytechnic Institute, Blacksburg.

The desirability of including a new section in *The Virginia Journal of Science* was discussed. The section members voted to recommend to the Board of Editors of *The Virginia Journal of Science* that they would favor publishing annually in the Proceedings Issue a list of titles, authors, and references of scientific contributions (Publications in Scientific Periodicals) by scientists residing in Virginia.

MINUTES OF THE SECTION OF ASTRONOMY, MATHEMATICS, AND PHYSICS [2]

H. V. LOH, *Chairman*

T. E. LOTHERRY, *Secretary*

F. L. HEREFORD, *Section Editor*

FRIDAY, MAY 7, 1954—10:00 A.M.—ROUSE PHYSICAL LAB.

1. APPLICATION OF THE POWER SERIES TRANSFORM TO DIFFERENCE EQUATIONS IN ENGINEERING.

Leonard McFadden; *Virginia Polytechnic Institute*.

The Power Series Transform of a sequence (y_k) is defined as $P(y_k) = \bar{y}(s) = \sum_0^{\infty} y_k s^{-k}$. A table has been compiled listing certain functions and their transforms.

In particular $P(y_{k+n}) = s^n y - s^n \sum_0^{n-1} y_k s^{-k}$

by means of which the linear difference equation $y_{k+2} + b y_{k+1} + c y_k = f_k$ with constant coefficients can be transformed into

$(s^2 \bar{y} - s^2 y_0 - s y_1) + f(s \bar{y} - s y_0) + c \bar{y} = \bar{f}$, from which it follows

$\bar{y} = \frac{\bar{f} + (s^2 + bs) y_0 + sy_1}{s^2 + bs + c}$. By means of the table (y_k) can be found.

The method is applied to certain difference equations in engineering.

The method is shown to be useful in solving linear difference equations with variable coefficients. From the list $P(k y_k) = -s \frac{dy}{ds}$

$$P\{(k+1) y_{k+1}\} = -s^2 \frac{dy}{ds} \quad \text{and} \quad P\{(k+2) y_{k+2}\} = -s^3 \frac{dy}{ds} - y_1 s$$

Hence if the coefficients in $A(k) y_{k+2} + B(k) y_{k+1} + C(k) y_k = f_k$ are linear functions of k the transformed equation will be a linear differential equation of the first order and first degree. The solution of the equation yields \bar{y} whose inverse can be found from the list.

2. THE DIFFERENTIATION OF LEBESGUE INTEGRALS.

E. J. McShane; *University of Virginia*.

It is well known that if f is Lebesgue integrable, and for each measurable set E we define $F(E)$ to be the integral of f over E , then except on

a set of measure zero F has a derivative and this derivative is equal to f . The usual proof is based on the Vitali covering theorem. In this note it is shown that another proof is possible, based on a lemma simpler than the Vitali covering theorem. The lemma can also be used to furnish a slightly simplified proof of the Vitali theorem.

3. TWO METHODS OF SPINNING ROTORS AT HIGH SPEEDS AND LOW TEMPERATURES.

J. W. Beams; *University of Virginia*.

In the first method the rotor is magnetically suspended inside of two or more concentric dewar flasks. The inner dewar contains liquid helium, and the outer dewar contains liquid nitrogen. The rotor is surrounded by a vacuum tight chamber and is driven by a rotating magnetic field. It accelerates in a way similar to the armature of an induction motor or to that of a synchronous motor.

In the second method the rotor is spun on the end of a long, small diameter, stainless steel hypodermic tube. The rotor is surrounded by a vacuum tight chamber which in turn is surrounded by a dewar flask containing liquid helium. A second dewar containing liquid nitrogen surrounds the inner dewar.

The methods are being used for experiments on the tensile strengths of materials at low temperatures on the properties of super-conducting materials and on the properties of liquid helium II.

4. THE MEASUREMENT OF TENSILE STRENGTH OF METALS AT LOW TEMPERATURE.

John B. Breazeale; *University of Virginia*.

Previous studies of the tensile strength of thin silver films show that for films less than a certain critical thickness the tensile strength increases quite rapidly. A study of the tensile strength of these films is now being made at liquid nitrogen and liquid helium temperatures. The tensile strength of a film is measured by electroplating it on a steel rotor, placing the rotor in an evacuated glass tube which is immersed in liquid nitrogen or liquid helium. The rotor is supported magnetically and spun by a rotating magnetic field until the film is thrown off. If the angular velocity of the rotor when the film is thrown off is known, the tensile strength can be calculated.

Preliminary results at liquid nitrogen temperature indicate that the strength of films much greater than the critical thickness does not differ much from the value found at room temperature. There is, however, some evidence that the value of the critical film thickness at which the tensile strength increases is greater at this temperature than at room temperature.

5. ADSORPTION AND SURFACE ENERGY.

N. Cabrera; *University of Virginia*.

Recently the idea of negative surface energy of solids has been used to

explain peculiar effects as, for instance, the growth of tin whiskers.¹ The purpose of this paper is to discuss the conditions under which this idea is correct and to suggest new applications.

First, it is pointed out that the idea is only applicable to the surface of separation of two phases, of a two or more component system, which are *not in equilibrium* with each other. An example could be a metal in the presence of oxygen. It is possible to estimate the pressures at which the surface energy of the metal becomes negative because of the adsorbed layer of oxygen;² this pressure should then be related to that at which the system metal-oxygen is not in equilibrium with each other but tends to form a compound. Considering the kinetics of the ensuing chemical reaction, it might be useful to assume a negative surface energy. A treatment along these lines is given for the sharpening of the tungsten point of a field emission microscope when in the presence of oxygen at high temperature.³

6. NEUTRON INDUCED SCINTILLATIONS IN PHOSPHORS.

R. Clapp and R. Wagner; *University of Virginia*.

We have investigated the response of various phosphors, both organic and inorganic, to neutron induced scintillations. NaI (Tl) and LiI (Sn) were the inorganic crystals investigated; benzene, deuterated benzene, and stilbene were the organic phosphors. Information as to the relative fluorescence efficiency of the electron, proton, deuteron, triton, and alpha particle has been obtained with respect to particular phosphors and energies. The experimental arrangement is described and conclusions drawn as to radiations present and the usefulness of the phosphors as neutron detectors is discussed.

7. THE MEASUREMENT OF MOLECULAR WEIGHTS BY THE EQUILIBRIUM ULTRACENTRIFUGE.

J. W. Beams and H. M. Dixon; *University of Virginia*.

In order to determine the molecular weights of substances whose molecular weights vary from one hundred to over one million, a sedimentation equilibrium ultracentrifuge has been developed which employs a magnetically supported steel rotor that is permitted to coast freely at a speed of several hundred revolutions per second in an evacuated and thermostatted chamber. The concentration of the solution in the centrifuge cell is determined with the aid of a modified Jamin interferometer, the necessary synchronized stroboscopic illumination of the interferometer being produced by the use of a slit in the rotor to admit light from a continuous source onto the interferometer at the desired moment.⁴ The weight average molecular weight of a substance of several species contained in a very dilute ideal solution is given by the equation

¹ F. C. Frank, Phil. Mag. 44, 854 (1953).

² C. Herring, p. 41 in *Structure & Properties of Solid Surfaces*, Chicago 1953; ed. by R. Gomer and C. S. Smith.

³ E. W. Muller, Zeit. f. Phys. 108, 668 (1938); Erg. exak. Naturwiss. 27, 290 (1953).

$$M\omega = \frac{2\pi\lambda RT}{(1 - \bar{v}\rho)\omega^2 \alpha(\mu - \mu_0)(\gamma_b^2 - \gamma_a^2)}$$

where π is the total fringe shift of light with wavelength λ in the interferometer. R is the molar gas constant and T is the temperature of the rotor whose angular speed is ω . $(1 - \bar{v}\rho)$ is the buoyancy correction for the material in solution, μ is the index of refraction of the initial solution and μ_0 is the index of refraction of the solvent. The thickness of the centrifuge cell is α , the radii from the axis of rotation to the inner and peripheral walls of the cell are respectively γ_a and γ_b .

8. THE EFFECT OF A CENTRIFUGAL FIELD ON DIFFUSION IN METALS.

Orville R. Harris; *University of Virginia*.

9. POSITRON ANNIHILATION IN LIQUID HELIUM.

Frank L. Hereford; *University of Virginia*.

Positrons in matter are known to capture electrons to form either singlet or triplet state positronium atoms (anti-parallel or parallel spins, respectively).⁵ Singlet positronium subsequently annihilates in about 10^{-10} sec. with emission of two photons; triplet positronium annihilates in about 10^{-7} sec. with emission of three photons. Actually most triplet positronium in solids is converted to the singlet state in a time much less than 10^{-7} sec. by means of collision induced electron exchange; hence, the ratio of 3-photon annihilations to 2-photon annihilations in solids is small (less than 1%). In most gases, however, the reduced electron density enables the triplet state to persist long enough for an appreciable number of 3-photon annihilations to occur. This simple explanation, however, fails to account for several anomalies in existing data.⁶ In a further attempt to clarify this situation, we have compared the ratio of 3-photon to 2-photon annihilations for positrons stopping in liquid helium to that for positrons in aluminum. It seemed possible that the smaller electron density and smaller frequency of thermal collisions in liquid helium might enable the triplet state to persist longer. This would result in a greater 3-photon to 2-photon ratio in liquid helium relative to that in aluminum. The experimental data, however, indicate no difference in the ratio. Apparently the electron density in liquid helium is sufficient to destroy triplet positronium in a time much less than 10^{-7} sec.

10. THE MAGNETIC BALANCE.

Charles W. Hulbert; *University of Virginia*.

The magnetic balance was originated after Dr. Beams⁷ noted that a small magnetically supported rotor dropped in position when the gas surrounding it was removed. This effect was attributed to the change in

⁴ Beams, et al., Rev. Scientific Instruments, 25, 295, (1954)

⁵ M. Deutsch, Phys. Rev. 82, 455 (1951).

⁶ Bell and Graham, Phys. Rev. 90, 644 (1953).

buoyancy. By visual observation, it was estimated that mass changes of 10^{-9} gram could be detected.

While investigating this effect, Dr. Lotz⁸ noted changes of 10^{-7} gram and estimated that changes of 5×10^{-9} gram could be detected.

The system used at present is the same as that used by Lotz.⁸ The noise level has been reduced by a factor of four. The sensitivity has been increased so that effective changes of mass of 10^{-9} gram have been observed when a sphere, 0.2 mm. in diameter is supported.

While working with nitrogen to calibrate the instrument, it was found that the sphere ceases to exhibit the buoyancy effect in the region about one mm. Hg or in some cases above. At pressures below this critical pressure, the sphere exhibits an effective decrease of mass, of a magnitude greater than the buoyancy effect. This indicates that the adsorbed gas, on iron or ferrite crystal, amounts to a greater total volume at NTP than the amount displaced at atmospheric pressure.

11. LATTICE SUMMATIONS IN CRYSTALS AND ENERGY OF TWIN BOUNDARIES.

Melvin M. Levine; *University of Virginia.*

By assuming Lennard-Jones potential interactions between the pairs of atoms it is possible to calculate the energy differences between various stacking orders of a close-packed layered lattice. These energy differences are quite small, the difference between hexagonal stacking (the lowest in energy) and face centered cubic (the highest) being of the order of .01%, with the intermediate polytypes being closer in energy.

This suggests the possibility that the different polytypes may be nearly equally stable energy-wise (although this treatment neglects the entropy contribution to the free energy) so that the appearance or non-appearance of the various structures may be attributed to differences in growth rates.

The calculations are done by considering the energy of an atom in the structure with respect to the various planes, applying a Fourier development (along the lines of that by Hove and Krumhansl in Physical Review 92, 3 (1945)).

12. DISPERSION OF THIN LAMINA.

H. Y. Loh; *Virginia Polytechnic Institute.*

Optical dispersion of thin lamina has been determined by means of channelled spectrum. By this method, samples of uniform thickness of a few square millimeters area are coated with highly reflecting metal film, and then the transmitted, channelled spectrum is taken at normal incidence with a calibrated prism or grating spectrograph. With one spectrum, many fringes can be obtained and the indices of refraction at these wave-lengths can be calculated.

This method requires one value of index of refraction at a known wave-length; that can easily be measured with a standard refractometer. It

⁷ Beams, J. W., Rev. Sci. Instr. 21, 182 (1950).

⁸ Lotz, W. E., Magnetic Balance Dissertation in Physics, Univ. of Va. (1953).

is applicable to laminae of crystal or other optical material with a thickness of about twenty microns or less. The wave-length range extends well over the visible region if a proper continuous light source is available.

The channelled spectrum of muscovite taken with a grating spectrograph and the dispersion curves of two polarized components, covering from 3300 to 6600A are shown. The accuracy of the method and the phase shift due to the metal film are discussed.

13. ANGULAR DISTRIBUTION OF PHOTOELECTRONS PRODUCED BY 0.4 TO 0.8 MEV POLARIZED PHOTONS.

William H. McMaster; *University of Virginia.*

The angular distribution of high energy (0.4 – 0.8 Mev) photoelectrons produced in Pb and Au foils by linearly polarized photons has been investigated using scintillation counting and pulse height analysis techniques. A Compton scattered photon beam from Co⁶⁰ provided a source of partially polarized radiation. The cross section for the distribution of K-shell photoelectrons was first calculated by Sauter⁹ using Dirac's relativistic wave equation. The cross section is of the form

$$d = A + B \cos^2 \phi.$$

In the non-relativistic limit the second term predominates in agreement with non-relativistic calculations. For high energies (0.5 Mev), the first term, containing the square of the energy, predominates,¹⁰ and the second term becomes negative resulting in photo-emission predominately orthogonal to the electric vector of the incident photon. Experimental results confirm this phenomenon and are in good agreement with the distribution predicted by Sauter.

14. AN INEXPENSIVE DEVICE FOR MEASURING X-RAY POWDER DIFFRACTION PATTERNS.

W. Richardson; *Virginia Polytechnic Institute.*

An easily made device for holding and measuring the line-spacing on powder diffraction pattern is described. Measurements are made with a vernier to 0.1 mm. The design of the instrument makes it convenient and easy to use. The major cost was \$4.00 for the steel scale used.

15. AN X-RAY DIFFRACTION MACHINE ASSEMBLED ALMOST ENTIRELY FROM WAR SURPLUS PARTS.

James Scott, R. K. Brown, and W. Richardson; *Virginia Polytechnic Institute.*

As an example of the use of war surplus parts in constructing valuable equipment for use in college laboratories, the design and construction of a half wave x-ray diffraction machine is described. The cost of new

⁹ F. Sauter, Ann. d. Physik 11, 454 (1931).

¹⁰ E. L. Hereford and J. P. Keuper, Phys. Rev. 90, 1043 (1953).

material used was estimated to be less than twenty-five dollars, less x-ray and rectifier tube. Commercial machines of comparative performance are priced at around \$3,000.00.

16. MECHANICAL STRENGTH OF THIN FILMS OF METALS.

Edward F. Turner, Jr.; *University of Virginia*.

The tensile strength of thin silver films has been investigated as a function of film thickness, using the techniques of Beams and others.^{11, 12, 13} Silver is electroplated on cylindrical steel rotors which are then magnetically suspended and spun in a vacuum. Adhesion of the silver films to the steel rotors is reduced by subjecting the plated rotors to alternate hot and cold baths with a 180 degree centigrade temperature range. In the absence of adhesion, the tensile strength is calculated from the equation $T = \rho \omega^2 R^2$, where ρ is the density of silver, R the radius of the rotor, and ω the angular speed at which rupture of the film occurs. Results of this investigation indicate the tensile strength does not exhibit the discontinuous increase reported earlier, but increases uniformly, beginning at thicknesses of the order of 10 centimeters. The shape of the curve is compared with theoretical predictions based on the Frank-Read scheme of anchored dislocations.¹⁴

17. COMMENTARY ON LOCATING AND CONSTRUCTING THE IMAGE OF A VIRTUAL OBJECT.

H. D. Ussery; *Virginia Polytechnic Institute*.

When in a train of several lenses, the image as formed by one element falls beyond the next element, this image is designated as the virtual object for the second lens.

The conventional construction for thin lenses requires the tracing of at least two principal rays from an object point through each element into the corresponding point in the final image.

In the not so conventional construction described in this paper, it is shown that the correct results may be obtained by reversing the sign of the second lens and considering the virtual object as a real object for the second lens. This necessitates two sign changes in the lens formula.

18. THE MEASUREMENT OF GYROMAGNETIC RATIOS BY A NEW METHOD.

Glen S. Waterman; *University of Virginia*.

At last year's meeting of the Virginia Academy a new method of measuring the gyromagnetic ratio in ferromagnetic materials by use of the magnetic suspension was described. The current experiments are an extension of the foregoing. Three, instead of two, coils are used, the upper coil being divided into an inner and outer winding of approximately the same number of turns. The lower coil is still a single winding. The rotor is

¹¹ T. J. Turner, Dissertation, University of Virginia (1951).

¹² W. E. Walker, Dissertation, University of Virginia (1952).

¹³ H. S. Morton, Dissertation, University of Virginia (1953).

¹⁴ F. C. Frank & W. T. Read, Physical Review 75, 722, (1950).

now supported and controlled only by the action of the inner winding of the upper coil. Variation of field intensity, hence, magnetic moment in the sample, is achieved through activating the outer winding of the upper coil and the entire lower coil independently. The advantages of this method are that the controlling current and the electronic control circuit need not be touched during the process of changing the field intensity, and as a result, more stability is attained. Further, the increased sensitivity and efficiency of control has permitted changing from a rotor of .73 mm. diameter with a rotating time of approximately 36 minutes to one of only .35 mm. diameter which can be turned at a rate equivalent to a period of only nine minutes. Due to magnetic coupling with the earth's field, at the present time it has not been possible to start with zero angular momentum and to cause it to rotate at the slow speed equivalent to a period of nine minutes. As a result, it has been necessary to start with a small initial rotation of approximately 16 rev. per min. and to measure the change in this due to the gyromagnetic effect.

19. THE VISUAL ORBIT OF MU ORIONIS.

Harold L. Alden; *Leander McCormick Observatory, University of Virginia.*

The star Mu Orionis is a triple system which presents some puzzling features. The brighter star is a spectroscopic binary with a period of 4.4 days and is the primary of a visual double with a period of 18.25 years. The relative visual orbit has been derived from observations by eight different observers on 80 nights since 1914. Assuming certain elements from spectroscopic data, the semi-major axis is found to be 0."254 and the inclination 98°. The computed dynamical parallax is 0."019, about 2/3 the weighted mean of five separate trigonometric determinations. Alternatively, using the trigonometric parallax, the mass of the system becomes 2.24 solar masses. This is about the mass to be expected for the primary alone. Furthermore the astrometric data obtained by Dr. Osvalds indicates that the visual companion possesses about 40 percent of the total mass of the system although it is only 1/10 as luminous as the primary. This is at variance with our accepted ideas of the relation between mass and luminosity.

20. PHOTOMETRY OF RED DWARFS.

George S. Mumford, III; *University of Virginia.*

In 1941 Vyssotsky began, at the Leander McCormick Observatory, a systematic survey of objective prism plates to discover red dwarf stars (spectral type dK8 to dM5). Since September 1953, the magnitudes and colors of 97 of these stars have been observed with the photoelectric photometer attached to the 26-inch visual refractor of the Leander McCormick Observatory. First results show that the average color of a dK8 star is +1.22 mags.; of a dM0, +1.38 mags.; of a dm2, +1.47 mags.; and of a dM5, +1.56 mags. The shift to the red in color for later spectral types is expected.

A color-luminosity diagram was drawn up for 25 of these stars whose parallaxes were known. Except for the bright stars, this diagram is similar to the red end of the standard ones of this type.

21. THE UNUSUAL VARIABLE STAR EZ AQUILAE.

Charles P. Oliver; *Flower and Cook Observatories, University of Pennsylvania.*

22. THE ASTROMETRIC ORBIT AND MASS-RATIO OF MU ORIONIS.

V. Osvalds; *Leander McCormick Observatory.*

Sufficient material for the astrometric orbit of this triple system has been collected at two observatories: Yale University Southern Station and McCormick. At the first one 59 plates have been taken with the photographic 26" refractor during the years 1928-47 covering slightly more than one period. One hundred and three plates have been taken with the 26" McCormick visual refractor during the years 1923-26, 1930-37, and 1946-53.

Measured and reduced, this material gives the following results:

<i>Solution</i>	<i>a</i>	<i>i</i>	<i>B</i>
McCormick	0".080	97°.8	0.41
Yale	.113	84.8	.46
Combined	.089	91.8	.43

a = semi-axis major; *i* = inclination; *B* = mass-ratio, companion to the total mass of system.

The first two solutions show a certain discrepancy which, at least partially, is a result of using different types of telescopes. For the same reason the combined solution should be taken without confidence since different type of measure have been combined.

In the last column are the mass-ratio-ratios obtained using *a* = 0".254 from visual orbit, derived by Professor Alden. The mean agrees with the mean obtained by him in 1944 using the material from the same observatories.

23. A BIBLIOGRAPHY OF LOGARITHMIC SPIRALS.

Georgie T. Davis and D. S. Davis; *Virginia Polytechnic Institute.*

A bibliography of spirals is presented under the headings of history of spirals, properties of spirals, spirals in nature, and miscellaneous uses of spirals.

24. SOME RELATIONSHIPS CONCERNING NEO-PYTHAGOREAN TRIANGLES.

Herta Taussig Freitag and Arthur H. Freitag; *Hollins College and Jefferson Senior High School, Roanoke.*

In Euclidean plane geometry of the complex domain, Neo-Pythagorean Triangles are defined as those triangles whose sides obey the condition that the sum of their squares vanishes.

Many relationships pertaining to Neo-Pythagorean Triangles are shown. Most of the theorems have valid converses of the form that, if the condition under discussion holds, then the triangle is either Neo-Pythagorean or degenerate. In some cases the triangle is either Neo-Pythagorean or else equilateral. No claim of completeness is made in the set of relationships developed.

The theorems state interdependencies of angles of Neo-Pythagorean Triangles, of sides, or sides and angles. There are formulas for area, circum-radius, in-radius, lengths of medians, and angle-bisectors.

The following examples illustrate the types of theorems found: In Neo-Pythagorean Triangles (1) the sum of the cotangent values of the angles vanishes; (2) the sum of the sixth powers of the sides equals three times the product of their squares; and (3) the cosines of the angles are proportional to the cubes of the corresponding medians.

The proofs of these theorems are based on the ordinary laws of trigonometry or of analytic geometry.

25. A BRIEF METHOD FOR TRANSFORMING RECURRING DECIMAL FRACTIONS TO COMMON FRACTIONS.

Herta Taussig Freitag and Arthur H. Freitag; *Hollins College and Jefferson Senior High School, Roanoke.*

The rational character of a non-terminating decimal-fraction is recognized by the occurrence of repeating decimal digits. Such decimal-fractions can be transformed into common fractions by the following method.

The whole number part of the resulting mixed number is the integral part of the given decimal.

The denominator of the fractional part of the mixed number has as many nines as there are digits in the "period" (repeating part) of the decimal. These nines must be followed by as many zeros as there are digits in the number's "ante-period" (digit or group of digits preceding the period). If the number does not contain an ante-period, no zeros will appear.

The numerator is the number obtained by subtracting the ante-period from the number written by reading the fractional part of the given decimal up to and including the first period. The numerator consists of the period alone if the number has no ante-period.

The proof of this method consists in expressing the given repeating decimal algebraically, using the summation formula of an infinite geometric progression for which $|r| < 1$, and performing certain simplifications.

26. IONIZATION IN FLAMES.

I. R. King and H. F. Calcote; *Experiment Incorporated, Richmond.*

27. A SET OF LECTURE DEMONSTRATIONS.

L. G. Hoxton; *University of Virginia.*

Shown for the first time, although some of the method shave been previously described (indicated by the year in parentheses) before the Section.

1. *Foucault Pendulum* (1933). The paths of the vertically projected image of a marker on the suspending wire swept out an angle of 4° in 26 min. as predicted by computation.

2. *Speed of Rifle Bullet*. Directly measured by shooting through two cardboard disks two meters apart on a shaft driven by a synchronous motor at 1800 rpm. Result 320 m/sec. (22 short ammunition).

3. *Falling Target* electromagnetically released 30 ft. from air gun and 22 ft. above table. Particular interest: large scale and use of lamp bulbs for targets. Gun (1928) aimed with light beam.

4. "Relativity Car" on Incline mounted a spring gun aimed upward perpendicular to the track. A steel ball would fall back to muzzle when the car was running freely in any manner on an incline as well as on the level.

5. *Complementary Colors with Polarized Light*. A doubly refracting prism was substituted for the "analyzer" in the usual arrangement. The two colored images projected on the screen could be made to separate or overlap by moving the prism along the optic axis. The overlap was white.

6. *Double Pendulum*. A light pendulum suspended from the bob of one much heavier was driven electrically. Invariably, after starting, the motion would settle down to one of its normal modes, the other dying out. The permanent mode could be predetermined by adjusting the relative lengths of the pendulums.

7. *Drinking Bird* viewed as a thermodynamic engine illustrating the second law by stopping when covered by a glass jar.

8. A few items such as an early form of the Beams high speed rotor, ripple tank, large scale Lenz law apparatus, and the curious fact that a piece of "BX" cable armor, when moistened, becomes a whistle. (First two items shown previously.)

MINUTES OF THE BACTERIOLOGY SECTION [3]

P. ARNE HANSEN, *President*

H. J. WELSHIMER, *Vice-President*

W. F. LAWRENCE, *Secretary-Treasurer*

J. DOUGLAS REID, *Section Editor (1956)*

SATURDAY, MAY 8-11:00 A.M.—ROOM C3—UNIVERSITY OF
VIRGINIA—SCHOOL OF MEDICINE

1. THE FERMENTATION OF GLUCONATE BY *Propionibacterium pentosaceum* AND ITS POSSIBLE ROLE AS AN INTERMEDIATE IN GLUCOSE METABOLISM.

Wesley A. Volk; *School of Medicine, University of Virginia.*

The operation of a typical Embden-Meyerhof pathway in the propionic acid bacteria has been suggested, but a clear demonstration of this is still lacking. Wood and Leaver (Fed. Proc. 11, 313, 1952) reported using glucose-1-C¹⁴ and glucose 3,4-C¹⁴ that the distribution of the tracer could not be accounted for on the basis of the Embden-Meyerhof scheme.

The present report presents data which suggest that there is a C₁ and C₅ split of hexose in addition to the presence of the Embden Meyerhof pathway. Using cell free extracts of *Propionibacterium pentosaceum* strain E214 a check revealed the presence of the following enzymes of the Embden-Meyerhof scheme: hexokinase, phosphohexoseisomerase, phosphofructokinase, aldolase, and enolase. Radioactive techniques have resulted in data indicating that perhaps two different pathways are being utilized simultaneously. When glucose-1-C¹⁴ was fermented 15% of the tracer was found in the metabolic CO₂. Since this indicated a shunt mechanism, gluconate-1-C¹⁴ was fermented and in this case 100% of the tracer was found in the CO₂.

Work is being continued using cell free extracts in an attempt to demonstrate the enzymes responsible for the dissimilation of glucose.

2. COMPARATIVE BACTERICIDAL EFFECTS OF MOIST AND DRY HEAT ON CERTAIN NONSPOROGENOUS BACTERIA.

H. T. Knighton; *Medical College of Virginia.*

Small sterile metal instruments (files used for treating root canals of teeth) were contaminated with 18 to 20 hour brain heart infusion broth cultures of micrococci, streptococci, or gram-negative nonsporing rods. The contaminated instruments were dried for 6 hours at 37° C. and subjected to hot oil (100° to 150° C.) and 100° C. water for varying periods of time. After desired periods of heating, each object was placed in a 10 ml. lot of broth medium and cultured at 37° C. for seven days.

Results indicated: (a) time required for bactericidal effects decreased approximately twofold for each 10° C. rise in temperature of hot oil between 100° C. to 150° C., and (b) 150° C. hot oil was necessary to equal 100° C. water in rapidity of killing all bacteria tested.

3. AN EXAMPLE OF A MULTISPOROGENOUS BACTERIUM.

H. J. Welshimer; *Medical College of Virginia.*

Slides are presented showing *Metabacterium polyspora* containing 2 to 8 spores per organism.

4. RESPIRATION OF *Mycobacterium paratuberculosis*.

Robert H. Miller and P. Arne Hansen; *University of Maryland, College Park, Maryland.*

Respiratory studies were carried out with three strains of *M. paratuberculosis* suspended by means of the surface active agent Triton A-20 in phosphate buffer at pH 6.4.

The low rate of respiration of this species (Q_{O_2} — about 7) in atmospheric air with lactate as substrate may be increased by using higher oxygen tension; however, the respiration even in 100 per cent oxygen, which gave the maximum rate, was only 32 per cent above the rate at 20 per cent oxygen.

Dextro and levo lactic acids are respired at approximately the same rate and the respiration is completely inhibited by M/500 HCN in both instances. There seems to be a slight recovery in case of the dextro lactate. The concentration of HCN was quantitatively controlled in the gas phase by virtue of a $Ca(CN)_2 - Ca(OH)_2$ center well mixture.

Nydrazid (M/80) and neomycin (16 units/ml.) inhibit the respiration temporarily.

It is emphasized that in order to obtain valid results, cell suspensions must be used in which proportionality will exist between amount of cells and oxygen uptake. This was true for cell suspensions in the range of 2-3 mg. cells per ml.

Respiration does not appear too sensitive to pH changes in the interval 6.4 — 7.0.

5. THE TUBERCULOSIS PROPERTIES OF ASCORBIC ACID.

Quentin N. Myrvik and Wesley A. Volk; *School of Medicine, University of Virginia.*

Ascorbic acid has been shown to be inhibitory for several species of microorganisms including the pathogenic mycobacteria. Several theories have been proposed to explain the mechanism of inhibition but all of them are unsatisfactory.

In the present investigation the possible role of the ene-diol group was investigated by determining the antibacterial spectra of ascorbic acid and the following substances (shown by paper chromatography to give rise to compounds containing ene-diol groups): diacetetyl, acetoin, inosose, and

dihydroxyacetone. All gave similar antibacterial spectra when tested against *Escherichia coli*, *Mycobacterium phlei*, *Pseudomonas* sp. and the BCG, H37Rv, and Ravenel strains of *M. tuberculosis*. In a series of short term experiments it was observed that diacetyl immediately inhibited growth, whereas fresh ascorbic acid failed to do so. These results suggested that the diketone (oxidized ene-diol) might be responsible for the inhibition rather than the ene-diol group. Experiments with other adjacent diketones support this hypothesis.

Chromatographic studies of autoxidized ascorbic acid in this laboratory have revealed two additional compounds with ene-diol characteristics. It is proposed that these as yet unidentified "reductones" arising from ascorbic acid are oxidized to diketones over an extended period and account for the antibacterial properties of autoxidized ascorbic acid.

6. SOME ENVIRONMENTAL FACTORS IN THE CULTIVATION OF *Endamoeba histolytica*.

E. Clifford Nelson and Muriel M. Jones; *Medical College of Virginia.*

Rice flour is an adequate nutrient for *Endamoeba histolytica* grown in a medium composed of an agar slant containing dibasic magnesium phosphate overlaid with phosphate buffered saline. The role of the magnesium phosphate appears to be a solid particle effect such as that noted by Bigger. Alundum, sea sand, and talc are equally effective. Efforts to demonstrate diffusion of an ameba growth promoting substance from rice flour were not successful.

7. ELECTROPHORETIC BEHAVIOR OF *Salmonella pullorum*.

Shelley Harrell and P. Arne Hansen; *University of Maryland, College Park, Maryland.*

The electrophoretic mobility has been determined for several strains of *Salmonella pullorum* using cultures which by serological tests had been classified as "standard", "variant", and "intermediate". The isoelectric point was found to be different for the three varieties. Working at pH 5.08 (acetate/barbital buffer) with a modified Brigg's microelectrophoresis cell, these forms could be differentiated by their rate of migration. Only "standard" strains moved toward the anode. "Variant" moved toward the cathode and at a faster rate than "intermediate" strains. As old cultures may show a very irregular behavior a number of frequent transfers is essential in order to obtain constant results.

8. THE GROWTH OF EHRlich ASCITES CARCINOMA CELLS IN THE SUCKLING RAT.

Michael Potter; *School of Medicine, University of Virginia.*

Ehrlich Ascites Carcinoma cells grown in the mouse and inoculated intraperitoneally in suckling rats of 8 to 24 days of age were found to proliferate rapidly. When a certain minimal number of cells is inocu-

lated death of the animal results in a high percentage of cases. The cause of death appears to be due to peritoneal hemorrhage and pulmonary infiltration by the tumor. Viable tumor cells can be isolated from the lungs of these rats. These cells of rat lung origin readily reproduce the typical ascites tumor in mice.

9. SOME EXPERIMENTS WITH THE MOLECULAR FILTER MEMBRANE TECHNIQUE AND DEMONSTRATION OF THE APPARATUS.

R. Travis Hill; *Virginia State Department of Health, Richmond.*

10. DEVELOPMENT, USE, AND EFFECTIVENESS OF B. C. G. VACCINE.

William F. Wagner; *Virginia State Department of Health, Richmond.*

MINUTES OF THE SECTION OF BIOLOGY [4]

ZOE WELLS CARROLL BLACK, *Chairman*

VERA B. RAMSBURG, *Vice-Chairman*

KENNETH P. STEVENS, *Secretary*

ROBERT T. BRUMFIELD, *Section Editor (1957)*

FRIDAY, MAY 7, 1954—9:00 A.M.—MAURY HALL

1. NOTES OF NUTRITION IN *Arcella discoides*.

John E. Davis, Jr.; *University of Virginia.*

Penicillin, dihydrostreptomycin, and aureomycin were added, both singly and in combinations, to clone cultures of *Arcella discoides* in attempts to obtain bacteria-free cultures. Pure (bacteria-free) cultures were obtained by the use of penicillin (1200-2000 units/ml.), dihydrostreptomycin (100 mg./ml.), and aureomycin (25 mg./ml.) singly, and penicillin in combination with either of the latter two. Combinations containing both aureomycin and dihydrostreptomycin resulted in a clouding of the cultures which rendered them useless. Contraction of cytoplasm and lack of division occurred in the absence of bacteria. This adds to the evidence for the necessity of bacterial flora or the metabolic products of bacteria for normal growth in *Arcella discoides*.

2. MORPHOLOGICAL OBSERVATIONS ON *Cambarincola Sp.*, *Oligochaeta*, *Branchiobdellidae*.

Benjamin Irving Johns; *University of Virginia.*

Since the published keys to the genus *Cambarincola* cannot be used to separate the many and varied forms found in the southeast, this morphological survey of a new species should be of taxonomic value. The emphasis has been placed on describing each system separately, and charts have been made to show the comparative differences of the members of the Subgenus *Coronata* already studied. This species of branchiobdellids has only been reported from the crayfish, *Cambarus sciotensis*, in Sinking Creek, Giles County, Virginia. The new species differs from other species of the subgenus in dental formula, body size, and shape of the copulatory bursa.

3. STAIN TECHNIQUE AND OBSERVATIONS FROM A PRELIMINARY STUDY OF MEGAGAMETEGENESIS IN *Ilex opaca*.

J. M. Herr, Jr., *Washington and Lee University.*

The safranine-fast green staining procedure described by Johansen (1940) and widely used in the study of megagametogenesis in Angiosperms is not entirely suitable for such a study in *Ilex opaca*. Safranine specifical-

ly stains lignified structures and some nuclear material; fast green is confined to the cytoplasm. Inadequate staining, therefore, results in the failure of these stains to affect cellulose cell walls, cell membranes, and nuclear membranes. Unstained, these structures are rarely visible in normal illumination, and they transmit light sufficiently to reduce the visibility of nearby stained structures. Adequate staining, however, is achieved when sections are first placed in a ferric ammonium sulphate mordant for $\frac{1}{2}$ hour, stained in a mixture of alcoholic hematoxylin and safranine for 24 hours, and finally are counterstained with fast green. The preparation of the mordant and the individual stains and the procedure for counterstaining is carried out as recommended by Johansen (1940). Use of a combination of 1 to 1.25 milliliters of alcoholic hematoxylin to 60 milliliters of safranine yields the most suitable results. Sections often appear very dark if the hematoxylin content exceeds 2 milliliters. Megagametogenesis in *Ilex opaca* follows the Polygonum-type with variation in regard to position of the functional megasporangium and behavior of the antipodal cells.

4. THE LOCALIZATION OF CHIASMATA IN THE X-BIVALENT OF THE GOLDEN HAMSTER.

Charles I. Sheaffer; *University of Virginia.*

The x-chromosome of the golden hamster at meiosis in the male consists of a deeply staining pairing segment and a more lightly staining slender, elongate differential segment. At the spermatogonial divisions the entire x-chromosome is contracted and stains uniformly. The differential segment represents approximately 7 percent of the x-chromosome and is indistinguishable from the pairing segment. In the female hamster the two x-chromosomes are uniformly contracted and the differential segment indistinguishable as in the spermatogonial mitosis. Chiasmata at meiosis are formed only between short arms of the x-chromosomes and hence are localized in those arms which are partly made up of the differential segment. The arm of the x, which in its entirety has no counterpart in the y and consequently cannot undergo crossing over in the male, is the arm in which chiasmata are localized in the female.

5. COMPARISON OF CERTAIN DEVELOPMENTAL FEATURES OF FIBER FOLLICLES OF SHEEP AND GOATS.

Lubow A. Margolena; *Agricultural Research Service, United States Department of Agriculture.*

A comparative study of dorsal and ventral fetal skins of 21 Karakul sheep and 19 goats was made. The age of the foetuses ranged from about six to 21 weeks. The follicular anlagen may appear from a unilayered epidermis upward of two months. In differentiated skins of both animals the epidermis proper is about three layers thick. The two generations of follicles that develop are essentially distinguished from one another by the same characteristics, namely, the primary ones develop accessory structures, while the secondary fail to do so. The topographic relation between the primary and secondary follicles is analogous in both animals.

The hardening of the inner root sheath and the development and keratinization of the primary fibers take place at approximately the time that elastic fibers make their first appearance. The hair canal is constructed from a differentiated region in the epidermis, a region formerly occupied by anlagal cells, and present much before the sebaceous gland. Epidermal melanoblasts play a special heralding role in relation to follicular anlagen of goats and sheep. Their appearance, distribution and the eventual pigmentation of the fibers are discussed. The blood supply in the skin is more abundant in goats than in sheep; capillaries are much more conspicuous in the follicular papillae of goats than in those of sheep.

6. CHROMOSOMES OF REPRESENTATIVES OF ALISMATACEAE IN GRAY'S MANUAL RANGE.

J. T. Baldwin, Jr. and Bernice M. Speese; *College of William and Mary.*

The Alismataceae are represented in the range of Gray's Manual by *Alisma* with three species, by *Echinodorus* with three species and one form, by *Lophotocarpus* with two species and three forms, by *Sagittaria* with sixteen species and eleven varieties and forms. Nineteen of the twenty-four species and nine of the fifteen intraspecific taxa have been cytologically investigated. Representatives of *Alisma* have $2n$ -numbers of 14 and 28; the other plants, $2n$ of 22. The four genera are separable on the basis of idiograms. Chromosomal evidence indicates that *Lophotocarpus* should not be merged with *Sagittaria*, as is sometimes done. The idiogram for *Sagittaria* is remarkably uniform from one species to another. *Sagittaria* chromosomes react differently to colchicine and to paradichlorobenzene: the authors have not observed this difference in plants of dozens of other genera that have been studied.

7. A STUDY OF NORMAL AND ABERRANT MEIOSIS IN OOCYTES OF THE NEWT, *Triturus viridescens*.

Asa A. Humphries, Jr., *University of Virginia Medical School.*

Study of meiosis in sections of 529 oocytes from the ovaries, coelom, and oviducts showed the meiotic process to be essentially similar to that described in most other amphibia. Ovulation ordinarily occurs shortly after the formation of the first meiotic spindle. Coelomic eggs, unless retarded in transit, are generally in metaphase I. The first polar body is most often formed while the oocyte is in the anterior one-third of the oviduct. Very few stages earlier than metaphase II were found in the posterior one-third of the oviducts. Submerged and/or tangential first and second meiotic divisions were observed, as were virgin eggs in the second division showing the diploid number of dyads and virgin eggs showing two separate haploid groups of chromosomes in the second division. These aberrant conditions provide an explanation for the occurrence of spontaneous polyploids and chromosome mosaics, and for certain diploid parthenogenetic embryos. Coelomic and oviducal eggs may be transferred from donor animals into foster mothers for fertilization. Such

eggs generally develop normally. The usual time required for passage of an egg through the oviduct seems to be about twenty hours. The shortest time elapsed was sixteen and one-half hours.

8. ECOLOGY OF THE RED CEDAR, *Juniperus virginiana*.

A. B. Massey; *Virginia Polytechnic Institute*.

Juniperus virginiana, red cedar, is generally scattered over the State. In the Valley of Virginia where the soil is thin over dolomitic limestone or where dolomite outcrops, juniper is commonly the pioneer arborescent species in abandoned clearings, forming juniper communities. In the Piedmont, juniper communities develop in association with dibasic rock. In the Coastal Plain, the development of juniper communities is associated with accumulation of shells in the soil. Circumstantial evidence indicates that some base in the soil promotes the development of juniper. The question arises, from circumstantial evidence, is the base magnesium?

9. NOTES ON THE EVOLUTION OF THE LONGULUS GROUP OF THE CRAYFISH GENUS *Cambarus*.

Horton H. Hobbs, Jr., *University of Virginia*.

Five members of the genus *Cambarus* inhabiting tributaries of the Tennessee, James, Roanoke, Yadkin, and Kanawha rivers in Tennessee, North Carolina, Virginia, and West Virginia constitute the Longulus Group. It is postulated that these crayfishes have a common ancestry with the members of the Extraneus Group, and that their progenitors migrated northeastward and westward from the southwestern foothills of the Blue Ridge and Smoky Mountains up the Tennessee Valley, into the New River System in Virginia, and finally into the James River. Since the ranges of the five species do not overlap it is obvious that geographic isolation alone would suffice to explain the divergence which has occurred in the primitive stock. In the absence of data from the fields of genetics, cytology, and serology no other isolatory mechanisms are postulated.

10. SULFUR NUTRITION AND THE AMINO ACID COMPOSITION OF FUR IN RELATION TO THE FUR-CHEWING SYNDROME IN DOMESTIC CHINCHILLAS.

C. O. Watlington, J. P. Baker, and K. W. King; *Virginia Polytechnic Institute*.

The cause of fur-chewing, a bizarre behavior common among domestic chinchillas, has been investigated from two approaches, (1) supplementation of the diet with Na_2SO_4 , methionine, and cystine and (2) analysis of the amino acid constituents of the fur. Data from a preliminary four-month feeding experiment using 21 animals whose rations were fortified with sulfur are presented. Qualitative paper chromatographic data on the amino acid composition of the fur and quantitative analyses using ion exchange chromatography comparing the amino acid composition of normal and fur-chewed pelts are presented.

11. PHYSIOLOGY OF DIAPAUSE IN THE GRASSHOPPER EMBRYO, STUDIED BY A NEW METHOD OF IN VITRO CULTURE FOR INSECT EMBRYOS.

Donald H. Bucklin; *The College of William and Mary.*

Embryos of the grasshopper *Melanoplus differentialis* have been removed from the egg and cultured *in vitro* from early stages to the stage of hatching, using a new method. The technique has been applied to several problems, including experimental analysis of compound eye development and of embryonic diapause. Embryos in a state of developmental arrest (diapause) were explanted to hanging drops of Ringer solution. Diapause was promptly terminated. Development resumed and proceeded at the normal rate to the stage of hatching. In addition to terminating a pre-existing diapause, this treatment prevented an incipient diapause, in explanted pre-diapause embryos. In an effort to explain this growth-stimulating effect, two factors have been manipulated, namely, the composition of the culture medium and the condition of the explanted embryo. The fact that diapause embryos resume development in a wide variety of media, including non-electrolytes, suggests that we are not dealing with stimulation of some dormant physiological system by specific ions. The fact that yolk-free fragments of diapause embryos resume development on explantation, suggests that the treatment does not act by stimulating the yolk cells or by activating an endocrine organ, as has been proposed by some authors.

12. THE SODIUM AND POTASSIUM ION CHANGE IN THE BLOOD OF HIBERNATING HAMSTERS.

Lucy Byrd Pegau; *University of Virginia.*

The process of hibernation is believed to be dependent upon the ability of certain homeothermic animals to undergo profound physiological changes. If such drastic changes do occur, the question was raised as to whether the sodium and potassium ion concentrations in the blood of animals would not undergo a marked change during hibernation since the normal concentrations of these ions are so intimately associated with the well-being of the living cell. Syrian hamsters were found to hibernate readily at temperatures of from 4° C. to 8° C. Blood was removed for analysis by cardiac puncture from these and from normal, awake animals. Flame photometric analyses were made on the blood of hamsters to determine the sodium and potassium ion concentration in the blood of hibernating and awake animals. The ion concentration readings from these blood analyses showed: 1. a control range for potassium from 3.7 m. eq. to 6.5 m. eq., with a mean value of 5.0 m. eq., per 100 cc. of blood; 2. an experimental range for potassium from 3.6 m. eq. to 11.3 m. eq., with a mean value of 7.2 m. eq., per 100 cc. blood; 3. a control range for sodium from 7.1 m. eq. to 11.6 m. eq., with a mean value of 9.2 m. eq., per 100 cc. blood; 4. and an experimental range for sodium from 5.0 m. eq. to 12.8 m. eq., with a mean value of 9.4 m. eq., per 100 cc. blood. Our results showed a marked increase in potassium ion content

in the blood of hibernating hamsters over the normal value, while these values for sodium did not show any striking change.

13. STUDIES OF OXYGEN CAPACITY IN RELATION TO SEX.

Jack D. Burke; *University of Richmond.*

Present data indicate that the oxygen capacity of the blood of mammals varies with the species. In a consideration of these data, it is known that various factors such as size, weight, ordinal characteristics, and habitat of various species of mammals have no specific relationship to the oxygen capacity of the blood. There is, however, an indication of a sex relationship to oxygen capacity in data reported by Gregersen. His investigations were made on normal male and female Chinese. Statistical and other pertinent data were obtained in studies made on albino rats and black mice. These animals were considered normal as evidenced by their blood picture. Data obtained from these mammals are presented in order to evaluate the degree of relationship of the oxygen capacity of the blood to different sexes. Oxygen capacities were determined with the Roughton-Scholander syringe apparatus.

14. AN INVESTIGATION TO ESTABLISH THE VIABILITY EXPECTANCY OF BULBLETS OF WILD ONION AND GARLIC *Allium Spp.* OCCURRING IN FIELD CROP SEED, BASED ON SIZE AND PHYSIOLOGICAL CLASSIFICATIONS.

C. M. Bass; *Virginia Department of Agriculture.*

Aerial bulblets of *Allium spp.* frequently occur in agricultural seed. These weeds are declared as noxious under the seed laws of most states. With improved machinery, progress has been made in removing these weeds from seed commonly seen in trade channels. There remain, however, types of bulblets which processors have not been able to remove. In as much as bulblets of these weeds when found in commercial seed vary in size and frequently are damaged by processing, it was believed that because of these factors, many of them are not viable. It was contended that if such bulblets were incapable of growth they should be classified under the official rules for testing seed as "inert matter" rather than "weed seeds". A study was made to determine the effect size and mechanical injury have on the viability of questionable bulblets. The investigation was based on size and physiological classifications. The following conclusions were drawn: 1. Size of bulblets has very little influence on germination. 2. Undamaged bulblets in the hull may produce strong germination. 3. Damaged bulblets show low germinating capacity. 4. Severely damaged bulblets showed almost no germination. 5. Bulblets in the hull have a greater germination potential than those out of the hull.

15. OBSERVATIONS ON THE CIRCULATION OF THE KIDNEY OF *Rana catesbeiana*.

E. W. Pullen and H. H. Hobbs; *University of Virginia.*

Evidence obtained in using vital stains in studies of the renal circula-

tion in *Rana catesbeiana* indicates that the renal portal vein is responsible for bringing that blood to the kidney which supplies the capillary network surrounding the tubules. No evidence of glomerular supply from this source has been found.

16. TEMPERATURE AND MOISTURE IN THE ECOLOGY OF EARTHWORMS.

William C. Grant, Jr.; *College of William and Mary*.

Experiments were conducted on two species of common lumbricid earthworms, *Allolobophora caliginosa* and *Eisenia foetida* and on one species of megascolecid worm, *Pheretima hupeiensis*. The water content of each species is the same, but their vital limits of desiccation vary. *A. caliginosa* is able to withstand a loss of water equal to 63.5 percent of its initial weight. Mature and semi-mature worms of each species desiccate at a faster rate than do juveniles. *E. foetida* and *P. hupeiensis* are more active on a wet than on a dry surface, while *A. caliginosa* is relatively inactive on both. The upper lethal level for worms conditioned at 22° C. was 24.9° C., 24.7° C. and 26.3° C. for *P. hupeiensis*, *E. foetida* and *A. caliginosa* respectively. In soil chambers, *P. hupeiensis* is most effective in mixing top-soil with sub-soil. Its castings are deposited beneath, and those of *A. caliginosa* on the surface of the soil. In the field, *P. hupeiensis* generally inhabits the sub-soil, being found only near the surface in seasons when moisture is high and temperatures moderate. During the winter months it remains in a state of hibernation at deep soil levels. *A. caliginosa*, having greater tolerances in general, lives near the surface in rich top-soils, where it is subject to wide fluctuations in temperature and moisture.

17. GENETICS OF CHLORDANE RESISTANCE IN THE GERMAN COCKROACH: PROGRESS REPORT.

F. E. Jarvis, Jr., J. M. Grayson, and M. Levitan; *Virginia Polytechnic Institute*.

Reciprocal crosses were made between chlordane-resistant and non-resistant strains of the German cockroach. F_1 and F_2 progeny have been tested for resistance. Results indicate incomplete dominance. Future work will include determining resistance of back crosses and that of the progeny of paired matings within strains and between strains.

18. OBSERVATION ON THE MAYFLY FAUNA IN AN UPPER PIEDMONT STREAM IN CENTRAL VIRGINIA.

Jean E. Pugh; *University of Virginia*.

During the course of a year's study of the mayflies inhabiting tributaries of the Buffalo River in Amherst and Nelson counties, some 5000 specimens, representing 19 genera and 27 species, were collected. The family Ephemeridae is represented here by two genera with one species each; the family Baetidae by 11 genera, eight of which have but a single species, one with two, one with three, and one with five species; and the

family Heptageniidae by six genera, five of which have but a single species, and one, with two. Observations on ecological and spatial distribution as well as seasonal data for this assemblage are presented.

19. A POLAROGRAPHIC STUDY OF RESPIRATION IN A BLUE-GREEN ALGA.
S. L. Cooke, Jr.; *University of Richmond.*

The problems involved in the adaptation of the polarographic technique to the study of respiration in a blue-green alga (Myxophyceae) have been investigated. Data related to factors affecting respiration rates are discussed.

20. MORPHOGENETIC STUDIES ON THE SUBTERRANEAN AXES OF *Psilotum nudum.*

David W. Bierhorst; *University of Virginia.*

The irregular branching patterns among the sporophytic and gametophytic subterranean axes may be referred to disturbances (mechanical injuries) occurring under natural conditions to the naked apical meristems. Apical injuries may result in the production of one to several new apical cells. These, and subsequent centers of growth, may produce new axes of equal or unequal sizes. The old apex may or may not become reconstituted and continue to produce the original axis. Dichotomies, trichotomies, apparent lateral branching, bends, and constrictions may thus arise in the system. The degree of development of the stele is correlated with the bulk of the meristematic apex. There seems to be a particular diameter of the apex above which a procambium will differentiate and below which none will appear; this is approximately one mm. for both sporophyte and gametophyte. Axes with apical meristems falling in a size range close to one mm. in diameter may possess central tissues of various degrees of differentiation, ranging from a complete stele through a series of intermediates to the complete absence of elongate elements. A discontinuous stele may be produced if the bulk of the meristematic tissue in the apex is fluctuating above and below the particular size necessary for procambial differentiation. Fluctuations in the bulk of the apical meristem appear to be directly related to mechanical injury and subsequent repair.

21. ABNORMAL OVULE DEVELOPMENT IN *Ilex opaca.*

J. M. Herr, Jr.; *Washington and Lee University.*

Variation with regard to the occurrence of abnormal ovules in *Ilex opaca* appears in two ovary collections taken on successive years in separate localities. Holly ovaries were first collected in Charlottesville, Virginia, during late Spring of 1952. The second collection was made one year later in Lexington, Virginia. All ovules examined (216) from the first collection showed normal development. In the second collection, however, approximately one out of six ovules examined (18 out of 123) showed abnormal development. Here, abnormality refers either to the cessation

of normal growth in immature ovules or to the initiation or maturing of ovules by aberrant growth characterized by the production of very large, irregularly shaped cells.

22. OBSERVATIONS OF THE EFFECTS OF SOME SUPPOSEDLY TOXIC SUBSTANCES ON EPHEMEROPTERAN NYMPHS.

James L. Larimer; *University of Virginia.*

Experiments were conducted to determine the limits of tolerance and effects of various substances on may-fly nymphs. The substances were selected according to their frequency of occurrence in streams polluted by industrial wastes. Various concentration of sulfuric acid, ferrous sulfate, calcium sulfate, and magnesium sulfate were used. Five animals were placed in 300-375 milliliters of each solution regulated to the desired concentration. The cultures were maintained in jars of about 500 milliliter capacity. These were immersed in running water to maintain a temperature below 20 degrees centigrade and an air hose was placed in each jar to furnish about 100 milliliters of air per minute. Records of the time, temperature, pH, and the number of surviving animals were made every twenty-four hours. The duration of each experiment was ten days. The test animal used was a member of the genus *Stenonema*, which is very common in the Charlottesville area, and readily available for experimental purposes.

Of the substances tested, the most toxic was sulfuric acid, and next was ferrous sulfate. Calcium sulfate was found to be less toxic than the previous two, but more toxic than magnesium sulfate. The order of toxicity runs, $\text{H}_2\text{SO}_4 > \text{FeSO}_4 > \text{CaSO}_4 > \text{MgSO}_4$.

At its business meeting, held on May 7, the Section of Biology elected the following officers for 1954-1955:

Chairman--Roscoe Hughes, Medical College of Virginia

Vice-chairman--Jacques Rappeport, University of Virginia

Secretary--Jack D. Burke, University of Richmond

Section Editor--Robert T. Brumfield, Longwood College.

MINUTES OF THE CHEMISTRY SECTION [5]

ROBERT C. KRUG, *Chairman*

J. STANTON PIERCE, *Secretary*

CARL J. LIKES, *Section Editor (1957)*

FRIDAY, MAY 7—9:00 A.M. and SATURDAY, MAY 8—ROOM 200,
COBB CHEMICAL LABORATORY

Introductory Remarks. Chairman Robert C. Krug; *Virginia Polytechnic Institute.*

1. STUDIES OF THE MECHANISM OF ANTIOXIDANTS (15 MINUTES).

James W. Cole, Jr., Lewis G. Cochran, Gordon P. Brown, and Minor F. Johnson, Jr., *University of Virginia.*

Small amounts of compounds with nitrogen and sulfur functional groups decrease the rate of oxidation of fluids at elevated temperatures. Information to assist in the understanding of the mechanism of action of such antioxidants is being accumulated by measurements of rates of oxygen absorption and the determination of changes in chemical composition. Spectrophotometric measurements assist in following the course of the reaction. It appears that for these additives to be antioxidants they become activated through a mechanism involving reactions with equivalent quantities of oxygen. The effect of metal surfaces on the behavior of additives is measurable but of a complex nature.

2. THE OXIDATION OF A SINGLE CRYSTAL OF IRON.

Bruce Wagner, Jr.; *University of Virginia.*

The relative rates of oxidation of several of the major faces of a single crystal of iron have been determined using interference colors as a measure of the thickness of the oxide films. The relative rates of the major faces in the temperature range 250° to 550° C. are: (100) > (111) > (110) > (320).

Structure and composition studies have been carried out using x-ray diffraction and the optical microscope. The composition and structure of the oxide film is dependent upon the temperature, pressure, and crystal face of the iron. For example, at 250° C. and 17 mm. oxygen pressure, the oxide formed on the (100) face of iron is highly oriented, the (100) plane of the oxide (either Fe_3O_4 or $\gamma - \text{Fe}_2\text{O}_3$) being parallel to the (100) plane of the metal such that the [110] direction of the oxide is parallel to the [100] direction of iron. Preliminary investigations of the oxide on the (110) and (111) faces indicate one degree of orientation.

3. THE STRUCTURE OF OXIDE FILMS ON COPPER SINGLE CRYSTALS.

Kenneth R. Lawless; *University of Virginia.*

Two oxides, cuprous and cupric oxide, form on copper, the amount of each and their structure depending on the conditions of the oxidation. Cupric oxide, when present, was found in all cases to be polycrystalline with a random orientation. The structure of the cuprous oxide, which always composed the bulk of the oxide film, varied depending on oxidation conditions and on crystal face. In general, increasing the temperature or decreasing the pressure caused an increase in the amount of preferred orientation. Both the type of orientation and the amount of orientation varied with crystal face. Four major orientations were found for the cuprous oxide, with in some cases two or more orientations occurring on a given crystal.

4. THE EFFECT OF CONTAMINANTS ON THE OXIDATION OF COPPER SINGLE CRYSTALS.

Kenneth R. Lawless; *University of Virginia.*

Small amounts of various impurities of foreign substances can cause tremendous changes in various catalytic reactions and in chemical reactions such as oxidation. Experience over a number of years has indicated the extreme sensitivity of copper single crystals to the presence of trace impurities. Using single crystal spheres of copper, a standard pattern is produced by oxidation when reacting materials and apparatus, including water supply, are as free of impurities as possible. Small amounts of impurities may cause vast changes in the oxidation pattern, and thus the use of a single crystal sphere provides a very sensitive method for indicating the presence of impurities. Experiments on the influence of various amounts of phosphate, and of silicone grease on the appearance of the oxidation pattern are reported.

5. THE INFLUENCE OF FOREIGN ATOMS ON THE CATALYTIC PROPERTIES AND SURFACE STRUCTURE OF METAL SINGLE CRYSTALS.

Robert F. Cunningham; *University of Virginia.*

The catalytic reaction of hydrogen and oxygen on large crystals of copper results in the rearrangement of the surface to produce definite facets parallel to certain planes. Under some conditions copper powder is formed, the amount of which depends on crystal face. Using a copper crystal in the form of a sphere so that all possible faces were exposed at some point on the surface, it has been previously shown by the author that the rearrangement is greatly influenced by the presence of small amounts of foreign substances such as silver, zinc, and chromium oxide.

In the present studies the rates of catalytic reaction were measured on isolated crystal faces with the aid of specimens having surfaces cut parallel to important crystal planes. Small amounts of the foreign atoms were evaporated onto the surfaces. The type of facets formed by the rearrangement, the rate of the catalytic reaction on the different faces, and the

formation of copper powder were greatly influenced by the presence of the foreign atoms on the surfaces.

6. STUDIES OF THE CHEMICAL PROPERTIES OF SINGLE CRYSTALS OF SILVER CHLORIDE.¹

Frances H. Cook; *Virginia Institute for Scientific Research.*

Studies were made of the etching of single crystals of silver chloride and of the reduction of the surfaces of single crystals of silver chloride to free silver.

Each single crystal was machined into a 5/8 in. sphere with a small shaft for handling and was mechanically polished with fine emery paper. The strained surface layer was removed by etching, and the crystal was polished with wool flannel moistened with sodium cyanide solution. These operations were carried out mainly in incandescent light.

Etching studies were made in solutions of 1% sodium cyanide, 5% ammonium hydroxide, and 10% (by volume) acid fixer. Although the three etch patterns differed, each indicated that the crystal was chemically anisotropic. Deep etching in acid fixer showed a tendency for the crystal to become a polyhedron. Development of specific faces was apparent under the microscope.

Surfaces of the polished crystal were reduced to free silver by exposure to sunlight, by photographic development, and by heating in hydrogen at temperatures of 200-350° C. Patterns indicating differences between crystal faces were obtained. Microscopic silver figures, whose shape depended on the orientation of the silver chloride crystal, were formed in two developers. Somewhat similar figures were found after reduction in hydrogen.

7. APPLICATIONS OF THE FIELD EMISSION MICROSCOPE.

Peter B. Sherry; *University of Virginia.*

Field emission microscopes are used to study the heat cleaning of tungsten and the adsorption of tantalum on clean tungsten. Field emission patterns indicate that at about 1800° K. oxygen dissolved in the tungsten metal is expelled and becomes adsorbed on the surface. Heating to a higher temperature will desorb the surface oxygen.

Tantalum diffuses readily over a clean tungsten surface at about 900° K. but tends to form small crystallites on the surface at room temperature if the tungsten is subjected to fields of about 5×10^7 volts per cm.

The vacuum system used for evacuating the field emission tubes will give pressures of 10^{-10} mm. of Hg with comparative ease.

8. THE ADSORPTION OF ORGANIC POISONS ON THE HYDROGEN ELECTRODE.

Thomas C. Franklin and Phillip Oglesby; *University of Richmond.*

A series of nitriles and amines are being investigated with regard to

¹ This research was conducted under Contract No. AF 33 (616)-323 with the United States Air Force, the sponsoring agency being the Aeronautical Research Laboratory of the Wright Air Development Center, Air Research and Development Command.

their poisoning effect on the hydrogen electrode. The potential of the electrode has been found to be a straight line function of the logarithm of the amount of adsorbed hydrogen. The logarithm of the fraction of the active area of the electrode covered by the poison has been found to be a straight line function of the logarithm of the concentration of the poison for both nitriles and amines. The strength of the poison has been found to increase with an increase in the molecular weight of the poison in the case of the nitriles.

9. AN INDUSTRIAL CHEMIST LOOKS AT FARMING (Guest Lecture).

Robert H. Kean; *Virginia-Carolina Chemical Corporation*.

Agriculture, the oldest industrial art of our civilization, is just beginning to feel the full impact of our scientific age. This has resulted in a rapid decrease in the proportion of our working force required for agricultural production, and in tremendous increases in agricultural productivity.

The increased use of chemical products in agriculture during the past twenty years has put our fertilizer and agricultural chemical industries in the group of our fastest growing industries. It is evident that even greater growth will be needed during the coming years, both in the production of fertilizers, in chemicals for control of agricultural pests, and in other agricultural fields.

Advances in fundamental chemical science, and related sciences have been the major factor in ushering in this coming "chemical age" of agriculture. In spite of progress made, however, we are far removed from levels of chemical use that are economically and scientifically desirable.

New scientific knowledge and new research tools of great potential value are just now becoming available for research in this field. The extremely complex physico-chemical and biochemical systems involved will require research of high order, and highly coordinated among the sciences involved. Such research, which is the foundation on which the continued development of agriculture must be built, presents a great challenge and a great need.

BUSINESS SESSION

Two business sessions were held by the Section. The first was at 12:05 P.M., May 7, and was devoted primarily to the election of officers for 1954-1955, and to a preliminary discussion of a proposal, submitted at the request of Dr. Boyd Harshbarger, and relating to the publication once each year in the *Virginia Journal of Science* of the titles, authors, and references of all articles published by Virginia authors during the year. Opinion was divided on this proposal, and final action was deferred until the following day. The report of the nominating committee was presented and the following officers elected by unanimous vote of the members present:

Chairman—J. Stanton Pierce, University of Richmond

Secretary—J. S. Gillespie, Jr., *Virginia-Carolina Chemical Corp*

At the second meeting, held at 11:00 A.M. on May 8, the proposal relating to the annual listing of authors, etc., in the *Journal* was again discussed and the following motion made, seconded, and carried: "It is the feeling of the Chemistry Section that more *information* concerning the publication of a list of authors is highly desirable and is awaited by the Chemistry Section." Notice of this action was conveyed, as required, to Dr. R. W. Engels, Biochemistry and Nutrition Department, Virginia Polytechnic Institute.

10. EFFECT OF SOLUTE CONCENTRATION ON SURFACE AND INTERFACIAL TENSIONS OF SEVERAL LIQUID SYSTEMS.

John E. Lastovica, Jr., and Nelson F. Murphy; *Virginia Polytechnic Institute*.

Surface and interfacial tensions were determined by means of a ring-type tensiometer. The following binary systems were studied: *n*-butanol-water, methyl ethyl ketone-water, nitromethane-water, furfural-water, and cyclohexanol-water.

Tertiary systems included in the investigation were as follows: methyl ethyl ketone-acetic acid-water, nitromethane-acetic acid-water, *n*-butanol-acetic acid-water, furfural-acetic acid-water, toluene-acetic acid-water, *n*-hexane-acetic acid-water, 1,1,2-trichloroethane-acetone-water, cyclohexanol-acetic acid-water, *n*-butanol-acetone-water, carbon tetrachloride-acetone-water, benzene-acetone-water, toluene-acetone-water, and *n*-hexane-acetone-water.

The various systems were chosen mainly because of their broad application in studies on liquid-liquid extraction. The temperature of the tests was maintained at 25° C. and at 27° C. Graphical methods for correlating variations in surface and interfacial tensions with changes in solute concentration are presented.

11. A STUDY OF THE ULTRAVIOLET ABSORPTION SPECTRA OF CHALCONES (BENZALACETOPHENONES).

W. Bruce Black and Robert E. Lutz; *University of Virginia*.

The band which occurs near 250 mu in the spectra of many chalcones has been conclusively shown to be due to absorption of the benzoyl portion of the chalcone molecule (possibly the phenylvinylketone portion in certain cases) by replacement of the benzoyl phenyl with a mesityl. This replacement which necessarily makes the benzoyl portion of the molecule non-coplanar resulted in the deletion of the 250 mu band of each of the parent chalcones.

In the spectra of a series of phenylbenzoylacetyleses evidence has been found that the band which occurs near 260 mu in certain of these acetylenes is due to benzoyl absorption.

The photoequilibrium positions of a number of cis-trans chalcone pairs have been determined spectroscopically. It has been found that they usually lie far over on the side of the cis isomer; however, the photoequilibrium positions of chalcones such as the α -phenylchalcone pairs and the

α -bromo-4-nitrochalcone pair, each of which has a long conjugated system (stilbene and α -bromo-4-nitrostyrene respectively) in addition to the cinnamoyl system, lie much less in that direction. These findings in the latter cases have been related to the increased stability of the cis isomer due to the stilbene or 4-nitrostyrene system.

12. RING-CHAIN RELATIONSHIPS IN THE 2-(N-ACETAL-N-BENZYLAMINO)-1,2-DIPHENYLETHANONE AND ETHANOL SERIES. THE MECHANISM OF CYCLOTRANS-ETHERIFICATION.^{1, 2}

Claibourne E. Griffin and Robert E. Lutz; *University of Virginia*.

N-Acetal-N-benzylamino-1,2-diphenylethanone and the two corresponding stereoisomeric ethanols have been prepared; and their structures were determined by ultraviolet absorption and by reduction of the former to one of the latter by aluminum iso-propoxide. Hydrolysis of the two types gave corresponding and more stable dihydroxy and monohydroxy-morpholines by essentially irreversible cyclization through the aldehyde group; the cyclic structures of these products were determined by ultraviolet absorption and by their reduction characteristics. Acid-catalyzed etherifications and trans-etherifications were easily effected in absolute alcohols. A small amount of water was necessary to effect cyclizations, however, and this is explained in terms of hydrolysis of the acetal group to the hemiacetal or free aldehyde. Dehydration of the dihydroxymorpholine gave irreversibly a hydroxydihydro-oxazine, the structure of which was shown by its stilben absorptivity. Lithium aluminum hydride reduction of this compound stopped after one stage and gave enolate-alkoxide, which only upon subsequent hydrolysis gave the then further reducible 2-hydroxymorpholine. Acid-catalyzed etherifications and trans-etherifications were easily accomplished.

13. THE PREPARATION OF DIALKYL ZINC COMPOUNDS.

Robert C. Krug and Phillip J. C. Tang; *Virginia Polytechnic Institute*.

During the course of some studies on the reaction of organo-metallic compounds with mono-chloromethyl ether considerable difficulty was encountered in the preparation of dialkylzinc compounds employing the usual zinc-copper couples. A very reactive zinc-copper couple was easily obtained from zinc dust and cupric citrate by heating the mixture in an atmosphere of nitrogen to decompose the salt to copper. The resulting couple readily reacts with certain alkyl halides to give the corresponding dialkyl zinc compounds. This new method gives easily reproducible results.

¹ This investigation was supported by a grant from the Eli Lilly Company.

² The term cyclo-trans-etherification is here used to include that process by which an open-chain ether linkage of the acetal group undergoes exchange of alkyls but where an oxygen atom elsewhere in the same molecule serves as the replacing group and leads to heterocyclic ring closure.

14. STRUCTURAL EFFECTS IN THE KINETICS OF SCHIFF BASE FORMATION.

Richard L. Hill and Thomas I. Crowell; *University of Virginia.*

The second-order rates of formation of several of the Schiff bases of piperonal, including those of the four isomeric butyl amines, have been measured at 25° C. in methanol. The purpose of this work was to learn whether a functional relationship exists between basicity of the amine and rate of formation of its Schiff base. There is no such correlation between the rate and the usual criterion of base strength, ionization constant. But if the known dissociation constant for the reaction, $\text{RNH}_2 \cdot \text{B}(\text{CH}_3)_3 \rightarrow \text{RNH}_2 + \text{B}(\text{CH}_3)_3$, is taken as a measure of amine basicity, a linear, relationship is found between the logarithm of the specific rate of formation of Schiff base and the free energy of dissociation of the $\text{B}(\text{CH}_3)_3$ addition compound of the corresponding amine.

15. A STUDY OF THE REACTION BETWEEN *o*-CHLOROBENZYL CHLORIDE AND NAPHTHALENE.

Frank A. Vingiello and Alexej Borkovec; *Virginia Polytechnic Institute.*

The Friedel-Crafts reaction between *o*-chlorobenzyl chloride and naphthalene yields a mixture of 2-chloro- α -naphthylmethyl benzene and 2-chloro- β -naphthylmethyl benzene. This reaction has been studied using different solvents and catalysts and at various temperatures in an attempt to obtain predominately α and β substitution at will. The experiments by which the above has been accomplished will be described.

16. β -TETRAHYDRO- AND DECAHYDROQUINOLYLETHANOL AS INTERMEDIARIES.

Charles J. Hansrote, Jr., Y. H. Chen, and J. Stanton Pierce; *University of Richmond.*

β -Tetrahydroquinolylethanol and trans- β -decahydroquinolylethanol have been found to react with p-alkoxybenzoyl chlorides and aryl isocyanates to yield esters and urethans, respectively.

17. SOME CONSIDERATION OF THE OCCURRENCE AND STRUCTURE OF PHOSPHATE MINERALS.

D. S. Sears; *Virginia-Carolina Chemical Corporation.*

A brief discussion is given of the origin and present disposition of the chief phosphate minerals, particularly of the Florida deposits. The composition and structure of some of these minerals is considered in relation to properties and isomorphism and to the inclusion of trace elements such as uranium.

18. STUDIES ON *O, O*, *O*-TRIAKYL PHOSPHOROTHIOATES.

C. L. Harowitz, C. E. Setliff, and J. R. Mangham; *Virginia-Carolina Chemical Corporation.*

The general chemistry of the O, O, O -trialkyl phosphorothioates is discussed, including the more important synthetic methods of preparation. Also covered is a comparison of the thermal stabilities of the phosphorothioates with analogous types of organophosphorus compounds.

19. THE PREPARATION OF SOME ALKYLPHOSPHORIC AMIDES.

J. R. Mangham and T. M. Melton; *Virginia-Carolina Chemical Corporation.*

A series of alkylphosphoric amides prepared by the reaction of alkylamines with phosphoric oxychloride is described. A difference is noted in the reactivity of primary and secondary amines. A new molar refractivity constant is derived for phosphorus amido nitrogen.

20. THE FUNGITOXICITY OF NICOTINE AND NICOTINE DERIVATIVES.

Lewis E. Goyete; *Virginia-Carolina Chemical Corporation.*

Thirty-five compounds structurally related to nicotine have been examined for their fungitoxicity. Included in this list were derivatives of nicotine, metanicotine, nicotinic acid, and nicotyrine.

A standard slide germination test was employed which used *Glomerella cingulata* and *Monilinia fructicola* as the test fungi. Values of ED₅₀ were determined for each compound and dosage-response curves were plotted. A correlation has been made between molecular structure and fungitoxicity.

21. A LABORATORY METHOD FOR THE EVALUATION OF ORGANIC PHOSPHORUS COMPOUNDS FOR INSECTICIDAL ACTIVITY.

M. A. Manzelli and V. H. Young; *Virginia-Carolina Chemical Corporation.*

A single test method has been developed for the rapid preliminary evaluation of organic phosphorus compounds for insecticidal activity and for determination of the relative effectiveness of these compounds. The procedure is a modification of previously reported methods, and employs adults of *Tribolium confusum*, the confused flour beetle, as the test insect.

The chief advantages of the modified method are the ease of culture of uniform specimens and the ability to consistently reproduce testing results. A relatively short testing time is required (48 hours). The active response of *T. confusum* to stomach and contact toxicants, to fumigants and to a lesser degree, repellents is an added advantage. It is possible to estimate relative mammalian toxicities of organic phosphorus compounds from the median lethal doses to *T. confusum*. It is also possible to correlate, generally, the preliminary laboratory screening results with those obtained in the future in the greenhouse and field.

22. MOLECULAR DIMENSIONS OF ZEIN.

Carl J. Likes; *Virginia Institute for Scientific Research.*

As the initial phase of a project designed to investigate the chemical and physical changes which occur in zein molecules during the produc-

tion of Vicara fiber, a blended sample of commercial zein has been studied by various techniques with the object of determining first the size and shape of the undenatured and unreacted molecule. The results of viscosity, sedimentation velocity, diffusion, and x-ray studies will be discussed. The overall evidence indicates that in aqueous iso-propyl alcohol solution the molecular weight of zein is in the neighborhood of 28,000 grams per mole, and that the molecule is only slightly coiled, the shape approximating that of a prolate ellipsoid with a length to breadth ratio of about 220 Å to 20 Å.

23. ANISOTROPIC SWELLING OF ZEIN FIBERS.

George L. Walker, Jr., and J. Samuel Gillespie, Jr.; *Virginia-Carolina Chemical Corporation.*

Various swelling agents have been examined for their effect on zein fibers. A study has been made of swelling anisotropy of samples of commercial Vicara zein fiber. In general, it has been found that increase in crystallite orientation as determined by x-ray diffraction was accompanied by reduced longitudinal swelling and that increase in reaction with formaldehyde decreased the degree of lateral swelling of these fibers.

24. CORRELATION OF MOLECULAR WEIGHT-DISTRIBUTION DATA FOR HIGH POLYMERS.

D. W. Levi and D. S. Davis; *Virginia Polytechnic Institute.*

Correlation of molecular weight-distribution data for high polymers can be achieved through the use of a new function $f = \log [20y/\log(100-y)]$, which facilitates rectification and differentiation.

25. CHEMISTRY OF CLORENE.

Albert W. Lutz; *College of William and Mary.*

Evidence has been found that clorene, a tricyclic isomer of the naturally occurring sesquiterpene caryophyllene, can be formulated as 4, 4, 8-trimethyltricyclo [6:3:1:0^{1,5}] docec-2-ene. Direct methods of degradation of clorene were fruitless due to the extraordinary stability of its oxidation product, clorenic acid. The proposed configuration is based on an

26. THE REDUCTION OF AROMATIC NITRO COMPOUNDS UNDER ALKALINE CONDITIONS.

Ira A. Updike and Edward C. Wilson; *Randolph-Macon College.* unambiguous correlation with a glycol whose structure has been elucidated.

This paper is taken from the senior project of the junior author, Class of 1954 Randolph-Macon College. The study was supported in part by a research grant from the Virginia Academy of Science, for which thanks are given.

It is generally considered that aniline is produced by acid reduction which, of course, is the usual procedure. We report the formation of

significant amounts of aniline by reduction of nitrobenzene with silicon-sodium hydroxide in water. It has been postulated by others that beta-phenylhydroxylamine is first formed which then undergoes auto oxidation-reduction to aniline and nitrosobenzene. Independent preparation of beta-phenylhydroxylamine and heating with silicon-sodium hydroxide confirmed aniline formation. Azoxybenzene, the first bimolecular stage of reduction, was obtained by condensation of nitrosobenzene and beta-phenylhydroxylamine and the azoxybenzene was further reduced to azobenzene in good yield, but neither hydrazobenzene nor aniline was obtained by further reduction for 100 hours at 100° C. A qualitative scheme for the detection of each of the possible reduction stages of nitrobenzene in the presence of the others was worked out and will be presented at a later date. Various substituted nitrobenzenes are scheduled for study in a similar manner in the immediate future.

27. THE EFFECT OF THE MEDIUM ON THE THIOSULEATE-ETHYL BROMIDE REACTION.

Francis B. Clough, Thomas S. Russell, and James C. Salonish; *Virginia Polytechnic Institute.*

A study has been begun on the effect of added salts on the reaction of ethyl bromide with S_2O_3 in $n\text{-PtOH} - H_2O$ mixtures of varying proportions, in order to obtain more data with regard to the effect of dielectric constant and ionic strength on ion-molecule reactions. Published data and theoretical discussions of the problem are in part contradictory. Data obtained so far in the study indicate that the reaction rate increases with increasing dielectric constant, and decreases with ionic strength, in qualitative accord with the deductions of Amis and Jaffe. At a dielectric constant of 30 the plot of $\log k/k_0$ vs square root of ionic strength is linear, even when such widely different salts as Na_2SO_4 and $La(NO_3)_3$ are present. The marked catalysis by La^{+++} observed for the reaction between S_2O_3 and bromoacetate ion is absent here, as might be expected.

28. SOME MODERN ASPECTS OF URINARY CALCULI IN RELATION TO DISSOLUTION BY ENZYMES.

Lawrence K. Claffey, David Levi, and S. Ford; *Virginia Polytechnic Institute.*

This investigation deals with the study of the dissolution of urinary calculi by various solvents in conjunction with enzyme pretreatment. A general review is made of all the solvents and enzymes used since the investigation was started in 1940.

Phosphate and carbonate calculi can be dissolved, or disintegrated to small fragments, "in vitro" by a one-hour treatment with hyaluronidase followed by a six-hour irrigation with 0.4% hydrochloric acid.

A fifteen-minute treatment with urease followed by a six-hour irrigation with 0.4% hydrochloric acid gave results similar, but somewhat less effective, than the hyaluronidase treatment indicated above.

Lithium carbonate solutions show promise as a solvent for urate type of calculi.

Density studies indicate that there is no relation between the density of the calculi and the dissolution by the various methods used in this investigation.

Swelling experiments seem to indicate that pre-treatment of calculi with hyaluronidase causes a swelling which enables the solvent to penetrate the calculi more efficiently.

29. A NEW REAGENT FOR THE COLORIMETRIC DETERMINATION OF TRACES OF MAGNESIUM.

Charles K. Mann and John H. Yoe; *Pratt Trace Analysis Laboratory, University of Virginia.*

2-Naphthol-3-(2,4-dimethyl)carboxanilide-1-azo-(2-phenol-5-sulfonic acid) forms a dark blue color complex with magnesium ions. This reaction has been found to be useful for determining magnesium in the microgram range. Methods for removal of interfering ions, based on chloroform extraction of oximates and on ion exchange, have been developed.

30. COLORIMETRIC DETERMINATION OF BORON WITH TETRABROMO-CHRYSAZIN.

Robert L. Grob and John H. Yoe; *Pratt Trace Analysis Laboratory, University of Virginia.*

A critical study of the reaction of tetrabromo-chrysazin with boron in concentrated sulfuric acid has been made. The mole ratio of boron to reagent has been determined by three quite different methods; each gave a ratio of 1:1. The rose colored boron complex reaches maximum intensity in one hour and is measured at 540 mu. The color reaction conforms to Beer's law and is sensitive to one part of boron in 50 million parts of solution, when absorbance measurements are made in 1.00 cm. cells. The tolerance of the colored complex to many diverse ions is accomplished by distilling off the trimethyl borate. The procedure is useful for the determination of trace quantities of boron.

31. POTENTIOMETRIC MICRODETERMINATION OF HALOGEN IN ORGANIC COMPOUNDS.

Everett C. Cogbill and J. Jack Kirkland; *University of Virginia.*

Potentiometric titration of halide with silver nitrate, employing a silver-amalgamated silver electrode system, has been applied to the microdetermination of chlorine, bromine, and iodine in organic compounds. The electrodes required are easily prepared and are small in size, permitting the titration to be carried out in volumes of five ml. or less. The titration is rapid and has a precision of 0.2 per cent. Ionizable halogen in organic compounds may be titrated directly after dissolving the sample in aqueous alcohol. For substances containing non-ionic halogen, the titration may be applied after catalytic dry combustion of the material in oxygen.

32. A STUDY OF SPECTROPHOTOMETRIC METHODS FOR THE DETERMINATION OF TRACE QUANTITIES OF BORON.

James E. Hardeastle, Emmett H. Poindexter, and W. Allan Purcell; *University of Richmond*.

A comparative study has been made of seven spectrophotometric methods for the determination of boron, all of which are similar in that they involve measurement of the intensity of color developed on addition of a solution of an organic reagent in concentrated sulfuric acid to the sample containing boron. Such factors as the wavelength of the incident light, the reagent concentration, the sulfuric acid concentration, time of development, adherence to Beer's law, reproducibility, and sensitivity were included in the study. Based upon the data obtained, the methods employing carminic acid and 1,1'-dianthrimide seem to be the most suitable of those studied.

33. INFLUENCE OF THE CYCLOPROPYL GROUP ON THE STABILITY OF COPPER CHELATES OF 1,3-DICARBONYL COMPOUNDS.

Barbara Ann Braun and Helen L. Whidden; *Randolph Macon Woman's College*.

The purpose of this study was to determine the structure of certain copper chelates and to see whether or not any influence on the stability of those containing the cyclopropyl group could be attributed to the cyclopropyl group alone. The 1,3-dicarbonyl compounds studied were 2,4-pentanedione; 1-cyclopropyl-1,3-butanedione; benzoylacetone; 1-cyclopropyl-3-phenyl-1,3-propanedione; ethylacetooacetate; ethyl- β -cyclopropyl- β -ketopropionate; and ethyl- γ -cyclopropyl- α , γ -diketobutyrate. Stability constants for the copper chelates formed with these chelating agents were determined from absorption spectra at wavelengths which gave a maximum difference in chelate absorbancy and that of the copper salt used. Employing Job's method of continuous variation a 1:2 structure for the copper chelates was established and the dissociation constants for each compound calculated. These values are discussed and explanations given for observed variations. The results show in general that the effect of the cyclopropyl group alone does not influence the stability of the chelates in many instances.

34. A PROGRESS REPORT OF THE STUDY OF COORDINATION COMPOUNDS OF POLYHYDROXYAMINES.

William E. Trout, Jr., J. Stanton Pierce, and Jane Bell Gladdings; *University of Richmond*.

Studies are being made to determine the nature of the complexes formed by 1, 3 bis(tris(hydroxymethyl) amino)-2-propanol dihydrochloride with Cu(II) and Fe(III). This compound is one of several polyhydroxyamines synthesized by Pierce and Wotiz.³ A Beckman D. U. spectrophotometer was used in the absorption studies.

³ J. Stanton Pierce and John Wotiz, *Jour. Am. Chem. Soc.* 66, 879 (1944).

The wave length of maximum absorption for the Cu(II) chelate was found to be 600 mu at pH 7 and at pH 9, and 610 mu at pH 4. Using Job's method to determine the ratio of Cu(II) to chelating agent by absorption, a maximum was found for an approximately 1:1 ratio. This was at pH 9.

The Fe(III) chelate gave a wide absorption band from 400 mu down to 320 mu. The amine alone gave negligible absorption in this region, while FeCl_3 alone absorbed much more strongly than the Fe(III) chelate at 350 mu but slightly less at 400 mu. The comparison was made necessarily at pH 3. The graphs of absorption versus ratio of Fe(III) to chelating agent showed definite breaks at 1:2 and 1:1 ratios but no definite maxima. Fe(III) was held in solution at pH 7.3 and at 4:1 ratio.

35. FACTORS INFLUENCING CHELATE FORMATION.

Maxwell L. Cluett; *Pratt Trace Analysis Laboratory, University of Virginia.*

Influence of structure of the organic reagent is shown in terms of the size of the chelate ring, number of rings formed, entropy effect, basic strength and chelate stability, resonance effect, nature of the donor atom, and effect of substitution on the ligand. Effect of the metal ion is described by correlating stability constants with periodic classification and ionization potentials. Influence of charge and radius of metal ion is also shown.

36. ELECTRICAL CONDUCTIVITY OF SOME MOLTEN SALTS.

O. L. Updike, Jr., and L. B. Johnson, Jr.; *University of Virginia.*

Measurements of electrical conductivity as a function of temperature from about 350° C. to 800° C. have been made for LiCl and for a mixture containing 90 mol per cent LiCl and 10 per cent KCl. Plots of $\log K$ vs $1/T$ gave straight line segments of different slopes for the liquid, liquid plus solid, and solid.

For a liquid-solid transition the conductivity was abruptly lowered. Its lowering appeared to occur, however, 5° to 10° C. above the temperature of the transition indicated by the phase diagram. This may be an indication of a strong tendency toward crystal orientation several degrees above the transition point. There were also indications that time was a variable in this region as well as was temperature.

MINUTES OF THE SECTION OF EDUCATION SECTION [6]

JOSEPH N. PAYNE, *Chairman*

JOHN B. CHASE, JR., *Secretary*

F. G. LANKFORD, JR., *Section Editor*

FRIDAY, MAY 7—9:00 A.M.—ROOM 122, CABELL HALL

1. LEADERSHIP AS A FUNCTION OF THE SITUATION.

Kathryne C. Bentley; *Highland Springs High School.*

It was the purpose of this study to ascertain whether or not leadership is a function of the situation. A leader was defined as the one who is chosen most often by the greatest number of people.

Information from student choices of leaders for the fifteen hypothetical situations was analyzed to show (1) the number of leadership choices each student received for all situations, (2) in how many situations the same leaders were chosen, (3) in how many situations each student was chosen leader, (4) which student was chosen most often as leader for each situation, (5) a student's leadership rating in one situation as compared with his rating in the situation following, (6) a reliability scale for leadership.

Within the limits of this study the following conclusions were made:

(1) Leaders can be determined experimentally. (2) From experimental studies of leadership in social situations, it is possible to predict leadership roles of the members of the group. (3) A long term association has no relation to leadership roles. A negative correlation was found between leadership and length of association. (4) Leadership is closely associated with participation in sports, social activities, and intellectual pursuits. (5) Teachers and guidance personnel can use ranking by associates to determine leaders in a group. (6) Leadership is a function of the situation to a significant degree.

2. ACCOUNTING FOR FINANCES OF CO-CURRICULAR ACTIVITIES IN SUFFOLK HIGH SCHOOL.

Arthur E. Jones, Jr.; *Assistant Principal, Suffolk High School,
Suffolk, Virginia.*

After the above study of schools in the Tidewater area, of which Suffolk is one, it seems there is a need for a well-planned central accounting system for the handling of all finances in co-curricular activities. In view of this, the following recommendations were made:

1. All schools, regardless of enrollment, number of staff, or number of activities, should have a central accounting system for the finances of the co-curricular activities.

2. Persons responsible for collecting funds from the various accounts should be bonded for the protection of the school and the individual.

3. The administration should make public at least quarterly the status of all school accounts carried in the central accounting system.
4. At the end of each month the administration should present to the superintendent and school board a complete report of all activities carried in the central accounting system.
5. The central account books should be audited by a certified public accountant at the end of each school year. A copy of this audit should be included in the principal's report to the superintendent and school board.
6. All accounts should be controlled by a double signing check system.

3. **A SURVEY TO DETERMINE THE EFFECTIVENESS OF STATE-WIDE AND LOCAL TESTING PROGRAMS CONDUCTED IN COOPERATION WITH THE RESEARCH SERVICE OF THE STATE DEPARTMENT OF EDUCATION.**

James B. Patton, Jr., *State Department of Education.*

4. **THE EFFECTIVENESS OF THE STATE-WIDE AND LOCAL TESTING PROGRAMS.**

Alfred L. Wingo and James B. Patton, Jr.; *Virginia State Department of Education.*

It was the purpose of this study to determine the effectiveness of the Virginia State-wide and Local Testing Programs. A compilation and analysis were made of responses to items on a questionnaire returned by 2,915 school personnel. The items on the questionnaire elaborated these key questions: (1) What information about (or better understanding of) pupils have you obtained through the use of standardized tests provided in connection with the State Testing Program? and (2) How have you used this information in the modification or improvement of your instructional practices?

Eighty-six school divisions, comprising 22 cities and 72 counties, participated in the survey. The personnel represented included 2,537 teachers, 307 principals, 35 supervisors, 13 directors of instruction, 4 guidance personnel, 7 librarians, and 12 miscellaneous groups and unidentifiable positions. A tabulation was made of the responses to each item on the questionnaire. Recorded was the number of persons responding to each item, their school positions, the number who checked each item "yes", and the percentages of such responses. The complete tabulation shows classifications by cities and counties, white and Negro, and a grand total of the responses to each item.

A tabulation of the responses to items elaborating the question concerning information obtained through the use of standardized tests showed that a substantial majority of the teachers reporting had gained useful information about their pupils. A substantial majority of the teachers also indicated that the information gained had resulted in modifications or improvement of their instructional practices. There were 2,230 teachers who reported their preferences regarding the use of standardized tests as a part of their teaching equipment, and 1,976 of them, or 88.6 per cent, preferred to use tests. The percentage of administrative, supervisor,

and other non-teaching personnel favoring the use of standardized tests was even higher, being 94.8 per cent. In the opinion of the authors, these findings are significant.

5. PRE-FRESHMAN MATHEMATICS IN STATE COLLEGES AND UNIVERSITIES.

Louise Hunter; *Virginia State College, Petersburg, Virginia.*

It was the purpose of this study to ascertain the status of pre-freshman mathematics in state colleges and universities. The major findings of the study were:

(1) Two hundred (or 74 per cent) of 269 institutions offered pre-freshman mathematics. The groups in which the highest percentages of the institutions offer pre-freshman mathematics were the junior colleges (92 per cent), land-grant colleges (85 per cent), and the technical college (73 per cent).

(2) Placement tests and admission units were the most widely used bases for selection and assignment of students to classes.

(3) Fifty-eight per cent of these institutions offer courses of this type for college credit. Forty-three per cent give non-credit courses in pre-freshman mathematics.

(4) Algebra is most frequently the content of pre-freshman mathematics courses. Seventy-eight per cent of the 200 institutions offer algebra.

(5) The instructional staff for such courses is the regular faculty in 93 per cent of the institutions.

(6) Textual material of greatest frequency was algebra.

(7) Eleven per cent of the institutions evaluated their results in pre-freshman mathematics as "excellent." Thirty-eight per cent gave ratings of "good," thirty-three per cent gave ratings of "average", fourteen per cent gave no rating.

(8) An estimated average of 78 per cent of students pass such courses. About 65 per cent of these students continue in college mathematics. Approximately 67 per cent of these succeed in college mathematics.

(9) Average of enrollments in pre-freshman mathematics in the technical colleges 132, in the state universities 400, land-grant colleges 400, teachers colleges 90, liberal arts colleges 170, junior colleges 65.

(10) Among important conclusions is the one that most satisfactory results seem to be obtained in offering pre-freshman mathematics where instructors have been free to do research with the problems of pre-freshman mathematics and write their own textbooks for such courses.

6. PROGNOSTIC VALUES OF FRESHMAN TESTS.

Walter N. Ridley; *Virginia State College.*

In this study six test results from each of 337 students in the 1947 and 1948 freshman classes majoring in agriculture, commerce, elementary education, physical education, and biology were used to determine the prognostic values of standardized tests regularly given at Virginia State College. Ways of improving the uses of these tests are suggested. Attention was given to estimates of prognostic values by freshman advisers, to

statistical estimates, to comparisons of advisers' and statistical estimates, and to those combinations of test performances which yield best estimates of student success.

Grade-point averages in all courses indicated the criterion, success in the major. Data were analyzed through ranges, ranks, means, standard deviations, coefficients of correlation (including simple, partial, and multiple regression statistics of zero, first, and second orders), simple and multiple regression equations, and appropriate measures of sampling errors.

Variations in prognostic values of these tests were found. Each one of the six results yielded a zero-order correlation as high as 0.50 with success in at least one major field. In four fields there was at least one zero-order correlation as high as 0.54; in two fields as high as 0.63; the highest as 0.68. Partial correlations in many instances were higher.

Freshman advisers as individuals and groups differed in their estimates. They varied from and were usually higher than statistical estimates of the prognostic values of the tests. It is estimated that prediction efficiency may be increased as much as 33% in one field, 26% in another, 17% in two fields, and only 9% in one field through proper use of regression statistics from this study.

7. A STUDY OF COMPETENCIES NEEDED BY SCHOOL ADMINISTRATORS AND SUPERVISORS IN VIRGINIA WITH IMPLICATIONS FOR PRESERVICE EDUCATION.

Prince B. Woodard, *Danville Public Schools*.

The study had a three fold purpose. First, it attempted to determine what competencies are needed for certain public school administrative and supervisory positions. Second, the essential competencies for each position were compared to determine the extent to which the same competencies are needed for all positions. Third, suggestions were made for a program of preservice education designed to develop the competencies essential for school administrators and supervisors.

The major findings of the study were as follows:

1. The survey of professional literature showed that the competencies reported as essential for the positions of school principal, school superintendent, and school supervisor respectively, are similar.
2. A large majority of the competencies reported in professional literature as essential for one or more of the positions of school principal, school superintendent, or school supervisor, were also reported as essential or of much value for these positions by each of the validating juries utilized in this study.
3. A majority of each of the validating juries of public school administrators and supervisors reported that their professional training had been adequate for 45 per cent or more of the total list of competencies .
4. A majority of each of the selected juries of public school administrators and supervisors was of the opinion that the proper place for instruction and experience in 90 per cent or more of the competencies was in both the preservice and inservice training programs.

5. Preservice training programs for school administrators and supervisors as currently offered in the selected group of institutions surveyed contained few required courses common to all programs.

6. The major portion of the preservice training program for both school administrators and supervisors should be concerned with the development of competencies in the ten areas considered essential for both administrative and supervisory positions by the validating juries utilized in this study. These areas were:

- Function and Scope of Public Education
- Communications
- Educational Foundations
- Human Relations
- Community Relations
- Curriculum
- Instructional and Guidance Activities
- Supervisory Services
- Evaluation and Research
- Related Educational Agencies

7. Specialized training designed to develop different competencies in the five areas of Related Disciplines, Personnel Administration, School Organization and Management, Financial and Budgetary Services, and Construction, Operation, and Maintenance of School Plant, should be provided in the preservice training programs for the five administrative and supervisory positions included in the study.

MINUTES OF THE SECTION OF ENGINEERING [7]

ROBERT W. TURITT, *Chairman*

PHILLIP L. MELVILLE, *Secretary*

ROBERT M. HUBBARD, *Section Editor (1958)*

FRIDAY, MAY 7 and SATURDAY, MAY 8—9:00 A.M.—ROOM 39,
THORNTON HALL

1. ROAD ROUGHNESS MEASUREMENTS ON VIRGINIA'S PAVEMENTS.

T. H. Forrer; Virginia Council of Highway Investigation and Research, University of Virginia.

The Virginia Council of Highway Investigation and Research studies pavement riding qualities as one of its continuing research projects. Measurements are made on all new concrete and much of the new bituminous pavements built in the Old Dominion. Comparisons of riding qualities and lasting characteristics of pavement surfaces are made from these measurements. Roughness readings can be used to stimulate competition among contractors as to who can produce the smoothest riding pavement.

Virginia's roughometer was built from plans developed by the U. S. Bureau of Public Roads. The machine is a single wheel trailer which is towed by a panel truck. It operates as a horizontal pendulum in dynamic balance so that it is not materially affected by the towing vehicle.

Before each operation the machine is carefully checked to assure constant tire pressure, oil level in the damping pots and other conditions. It is then towed through the project at 20 mph. For any pavement length, units of roughness are measured cumulatively in inches by the integrator and expressed in inches per mile.

Road roughness measurements are an important part of the constant effort to make Virginia's highway system ever safer, more comfortable, and more enjoyable for the motoring public.

2. AN AUTOMATIC TUNING BANDPASS FILTER.

H. L. Beazell, Jr.; University of Virginia.

The signal from a doppler radar velocimeter normally contains a considerable amount of noise and other interference. In the Sperry Model 10A Velocimeter the desired signal frequency range is 3kc. to 30 kc. To improve the quality of this signal previous to recording, a tracking filter was constructed which has an effective band width of 800 cycles and automatically follows a frequency varying signal between 3kc. and 30 kc.

The filter operates by converting the incoming signal and passing it through a 70kc. fixed tuned amplifier having a bandpass of 800 cycles.

The signal is reconverted to the original frequency by mixing with the conversion oscillator signal. This output is then passed through a 30kc. low pass filter and amplified by an automatic gain control amplifier.

Since for proper operation the output of the fixed tuned amplifier must be maintained at 70kc., by passing a portion of this output through limiters and a frequency discriminator tuned to 70kc., an error signal is obtained that indicates the direction of tuning error of the conversion oscillator. To provide automatic tracking the error signal is applied to a servo amplifier. The motor of the servo system is geared to the shaft of the tuning condenser of the conversion oscillator.

3. ORGANIZING MECHANICAL DESIGNS.

B. A. Niemeier; *Faultless Engineering and Machine Corporation.*

The role of the engineer in planning physical devices for society is reviewed as an introduction to outlining the key individuals in planning a mechanical design. Emphasis is laid on the responsibility on the part of the draftsman, engineer, checker, as well as the authority who approves the design for an issuing company. A title block and cross reference system of numbering the assembly, sub-assembly and detail drawings, are presented. In defining items on the assembly drawing which are to be drafted further as a sub-assembly the author recommends surrounding such encircled item numbers with squares.

4. PRESSURE DISTRIBUTION AROUND A CIRCULAR CYLINDER IN A TWO-DIMENSIONAL NON-UNIFORM FLOW.

Joseph Hendricks; *Virginia Polytechnic Institute.*

The stream function for a circular cylinder in an incompressible, inviscid fluid having a non-uniform velocity distribution at infinity was developed by H. T. Nagamatsu. An expression for the pressure coefficient can be derived, and the pressure distribution around the cylinder predicted. The equation for the pressure coefficient predicts a higher maximum velocity and a higher negative pressure on a cylinder in shear flow as compared to the pressures on a cylinder in a uniform flow. The increase in the maximum velocity and pressure is a function of the vorticity or curvature of the velocity distribution and the diameter of the cylinder.

A non-uniform velocity distribution has been obtained in a subsonic wind tunnel. The pressure distributions on six circular cylinders immersed in the shear flow was measured. These pressure distributions are compared to the theoretical results and also to the distribution on a cylinder in the uniform flow of a real fluid.

The experimental results show that the maximum negative pressure is greater at an angle of $\pm 90^\circ$, and that the point for $C_p = 0$ is approximately $\pm 50^\circ$ from the direction of flow. While in the uniform flow the maximum negative pressure occurs at approximately $\pm 70^\circ$, and $C_p = 0$ is at $\pm 39^\circ$.

5. P-V-T RELATIONSHIPS FOR TRICHLOROMONOFUOROMETHANE.

Robert L. Brehm and D. S. Davis; *Virginia Polytechnic Institute*.

For superheated trichloromonofluoromethane, V, the specific, V, the specific volume, in cubic feet per pound, T, the temperature in degrees Rankine, and P, the pressure in pounds per square inch absolute, are related by the equation

$$V = \frac{T - 2.066 P + 0.00392 P^2}{13.84 P^{0.9592} - 1.00}, \text{ which is reliable to about 0.8 per cent.}$$

6. INVESTIGATION OF PRESSURE DISTRIBUTION OF A 180° WEDGE.

R. W. Truitt and J. C. Williams, III; *Virginia Polytechnic Institute*.

Investigation of small angle wedges in bounded and unbounded, compressible and incompressible flow has been treated in literature, however, the limiting case, the 180° wedge, has not been investigated until recently.

In this paper, the 180° wedge is analyzed for incompressible flow in both bounded and unbounded streams by the Schwartz-Christoffel transformation. It is found that theoretically the boundaries (wind tunnel walls) do not appreciably affect the pressure distribution on the front fact of the 180° wedge for tunnel-wedge ratios above 7.

An experimentally determined pressure distribution on the front face of a 180° wedge in an unbounded stream, at a free stream Mach number of 0.1 was corrected for compressibility by the Sound-Space Theory. The local Mach number on the front face of the 180° wedge was not constant in the transonic range as is normally assumed for small angle wedges. For every subsonic free-stream Mach number in the range of 0.6 to 1.0 there is a corresponding supersonic free stream Mach number at which the local Mach number distribution is identical. This local Mach number distribution was converted to p_L/p^* values and checked against experimental work by Griffith at Princeton.

7. SKID TESTS FOR SAFETY.

Alfred W. Maner; *Virginia Department of Highways*.

The Virginia Department of Highways has been conducting skid resistance measurements on Virginia pavements since 1947. Approximately 3,000 skid tests have been made on bituminous surfaces containing such aggregates as limestone, granite, natural sand, manufactured stone sand, and blast furnace slag. Other surfaces tested include concrete, natural rock asphalt, and sand-asphalt containing small amounts of natural, synthetic, and reclaimed rubber.

Equipment used consists of a stock 1950 automobile, a detonator for firing a piece of chalk onto the pavement when the brakes are applied, a water truck, a 100 foot tape, signs and barricades. A new fifth wheel attachment for the test car will measure the accurate speed of the car and the stopping distance for the test.

Briefly, the test procedure is as follows: The water truck wets the pavement surface. The driver runs the test car onto the wet pavement at a predetermined speed (10, 20, 30, or 40 miles per hour), applies the brakes, and the car skids to a stop. The stopping distance is measured and recorded and the coefficient of friction is computed.

Results are used to accumulate data on various surface types for analysis, for planning resurfacing programs, and for investigating accidents.

8. SOME PROBLEMS OF BEAMS RESTING ON ELASTIC FOUNDATIONS INCLUDING EFFECTS OF SHEAR AND NORMAL PRESSURE.

Dan Frederick and Frederick G. Blottner; *Virginia Polytechnic Institute.*

An approximate solution which includes the effects of shear and normal pressure is deduced for a beam resting on an elastic foundation using the equations of elasticity. The theory is then applied to two problems and compared with the results obtained by the classical theory. The two problems considered are: (a) a semi-infinite beam with a moment on the end, and (b) a finite beam with clamped ends deflected by equal loads on its ends.

9. MODEL STUDIES OF PILE FOUNDATION SUBJECT TO LATERAL LOADING.

R. K. L. Wen; *Virginia Council of Highway Investigation and Research, University of Virginia.*

Tests were made in three series, namely: single pile, group of two piles, group of three piles. Each series consisted of four tests. Both vertical and battered piles were used.

Model piles were made of 1½" square white oak 45" long. S. R. 4 strain gauges were installed on opposite sides of each pile along its length, making it possible to segregate axial strain and flexural strain. Piles were clamped by two steel channel pieces simulating a concrete cap. Vertical and horizontal translations and rotation were measured with three mechanical dials. A tank filled with fine beach sand was used as a test pit.

Test results indicate: (1) Battered piles are advantageous in resisting lateral load. (2) Piles battered in the direction of the horizontal load offer greater resistance than piles battered against the load. (3) As horizontal load increases, the front pile or piles take up a greater proportion of external load. When horizontal load approaches the magnitude of vertical load, the average ratio of horizontal load taken by the piles is about 2:1 for two-pile group and about 7:5:3 for three-pile group, with the front pile taking all the vertical load plus the tensile force developed on the back pile or piles.

10. GUIDED MISSILE AIRFRAME RESPONSES.

C. D. West; *McDonnell Aircraft Company, St. Louis, Missouri.*

11. REVERIES OF AN ENGINEER.

W. R. Glidden; *Virginia Department of Highways.*

By extrapolating the record of history man can foresee either the destruction of civilization or its continuance for centuries; there is historical basis for either outlook. A minimum of government by honest intelligent people of the world, possibly after amalgamation of the present races, with an effort to obtain the greatest dissemination of knowledge and dispersion of advanced culture constitutes our main reliance for the future of civilization.

12. STRUCTURAL APPLICATIONS OF ALUMINUM ALLOYS.

Charles N. Gaylord; *University of Virginia.*

Aluminum alloys have been successfully used for many types of Civil Engineering structures. The two alloys generally used are 14S-T6 and 61S-T6. 14S-T6 is a high strength alloy with a basic allowable tensile working stress of 22 ksi and 61S-T6 is a moderate strength alloy of high resistance to corrosion.

Aluminum floor beams, stringers, and tread plates were used in the rehabilitation of the Smithfield Street Bridge, Pittsburgh, replacing the original iron floor beams and stringers and timber floor. The reduction in the panel dead load permitted an increase in the allowable live load from 13 ton trucks to 20 ton trucks.

One 97.5 ft. unit of the Grasse River Bridge was constructed entirely of aluminum. Because of the high base price of the metal and the inefficient use of the web material, aluminum cannot compete economically with steel in application to plate girders.

The applications where aluminum can be used to advantage are in bridge floors, bascule and lift bridges, suspended spans of cantilever bridges, and curtain walls for buildings.

13. SOME FUNDAMENTAL THEOREMS ON SIMILAR AND DISSIMILAR ELASTIC MODELS.

Daniel Frederick; *Virginia Polytechnic Institute.*

Four theorems concerning elastic models are deduced from the equations of linear elasticity. Considering the initial and deformed states, it is seen that the final states may be dissimilar although the initial states were similar.

Equations relating the loads, moments, displacements, stresses, and strains between the model and prototype are also given for each of the four cases. Two of the theorems deal with materials having different elastic constants.

14. THERMAL ANISOTROPY AND CONDUCTIVITY OF NYLON 66.

Arthur C. Doumas and Robert A. Fisher; *Virginia Polytechnic Institute.*

The thermal conductivity of nylon 66 as a function of internal structure and direction of heat flux was studied. The internal structure of cast

nylon was varied by cold-rolling and annealing, and the effects of these treatments were followed by measuring the degree of crystallinity and thermal conductivity. The density of cast nylon was increased from 1.1349 at 25°/4° C. to 1.1508 at 25°/4° C. by these treatments, and the degree of crystallinity was increased from 18.6 to 30.8 per cent. The rolling operation produced orientation of the nylon molecules, and also resulted in anisotropy of thermal conductivity of the nylon.

15. THE CONSTRUCTION OF INFLUENCE LINES WITH A MECHANICAL INTERFEROMETER.

James Howard Sword; *Virginia Polytechnic Institute*.

Influence lines have proved to be a useful tool for structural designers. Several methods of constructing these lines by means of models have been used with varying degrees of success. A different technique, employing mechanical interferometry, has been investigated. Three models have been tested. The models, cut from a ruled sheet of cast Lucite, included a fixed-ended beam, a two-span continuous beam and a symmetrically haunched arch. Influence lines for moment at a support and for end reaction or shear have been drawn for all three models. In addition, the influence line for thrust was drawn for the arch. The experimental results thus far obtained agree very closely with the results of theoretical investigations.

16. FLOW VISUALIZATION BY SCHLIEREN TECHNIQUES FOR MIXING STUDIES.

Barbour B. Wilson and O. L. Updike, Jr.; *University of Virginia*.

Schlieren techniques have been used to study high velocity gas streams for many years, but they are not usually considered for low speed flows. They will, however, show up density differences in a gas, whether from differences in temperature, in pressure, or in composition. Mixing of different gases may thus be studied. The present work deals with carbon dioxide injected into an air stream. Equipment has been assembled with a concentrated-arc light source and a single parabolic mirror, and mixing patterns have been photographed. Further studies are expected to yield correlations of mixing distance with injection method and with velocities of air and injected gas.

17. AN INVESTIGATION OF FURNACE WALL HEAT LOSS.

F. A. Iachetta; *University of Virginia*.

A study was made of a method used for furnace wall design. The design procedure assumes temperature values which are used to estimate the heat lost by radiation and convection. In this case, convection is considered to be 50% of the radiation loss as compared from the assumed temperatures. Based on this heat loss, refractory and insulation materials are selected.

The losses of a furnace wall were determined using temperatures measured by thermocouples placed in the wall. These temperatures, together

with k factors of the wall materials, were used to calculate the heat conducted through the wall which was transferred to the ambient air by radiation and convection.

A method was devised to make possible the calculation of convection. The value of air velocity was needed to permit use of forced convection rather than a natural convection analysis. This work was based on the assumption that air velocity, usually unknown where natural convection is involved, was the only quantity preventing a forced convection analysis.

The results indicated reasonably good agreement between average measured heat loss values and predicted values, though the convection investigation results were not wholly satisfactory. Recommendations, however, were made pertaining to test procedure refinements intended to improve results.

BUSINESS MEETING

Chairman R. W. Truitt called the business meeting to order at 4:00 P.M. Friday, May 7. It was agreed that the award made to a Junior Scientist should be continued; a motion was made, seconded and carried that the new chairman should head the award committee for the next year. The chairman appointed Messrs. Murphy, Melville, and Updike as judges for the 1954 award. From four competitors describing their exhibits, Walter S. Thomas from Kempville High School was selected as the recipient. The officers elected for the year 1954-1955 were:

Chairman--Phillip L. Melville

Secretary--Dudley Thompson

18. AN INSTRUMENT FOR RECORDING THE EARTH'S ELECTRIC FIELD.

Robert F. Fleming, Jr.; *University of Virginia*.

As an insulated probe is alternately exposed to and shielded from the earth's electric field, an alternating voltage is inducted on the probe. This voltage is amplified, switched at a synchronous rate, and applied to a graphic indicator as a direct current which is proportional to the polarity and magnitude of the earth's field, thus providing a plot of field vs. time.

19. EXTRACTION AND EVALUATION OF TOBACCO SEED OIL.

Robert A. Fisher; *Virginia Polytechnic Institute*.

The oil content of dry Virginia Burley tobacco seed has been found to be 40.7%. Cold pressing yielded 11% oil, hot pressing 17% and solvent extraction yielded the total oil content. Cold pressed oil was slightly superior in quality to hot pressed and solvent extracted oil, but the difference was not great. The component fatty acids of tobacco seed oil are oleic, linoleic, and a small percentage of saturated acids; the iodine number of seeds collected from six states varied from 110 to 135. Linseed oil contains linolenic acid in addition and its iodine number is 170 to 200.

In spite of its relatively low iodine number, tobacco seed oil was substituted for linseed oil in the preparation of an alkyd resin with completely satisfactory results. Interior varnish formulated with ester gum and turpentine, and spar varnish formulated with dehydrated castor oil and modified phenolic resin were prepared with linseed oil and with tobacco seed oil. The tobacco seed oil varnishes required 10 to 25 per cent longer drying time, but the film was equal to linseed oil varnish in all respects and in some cases was superior in resistance to hot water and alkali.

20. EFFECT OF ULTRASONIC INSONATION ON SOLVENT EXTRACTION OF OIL FROM PEANUTS.

Dudley Thompson and D. G. Sutherland; *Virginia Polytechnic Institute*.

This investigation was concerned with the determination of the effect of intensity and time of 400-kilocycle insonation on solvent extraction of oil from peanuts. Normal hexane was employed as solvent. Insonation times included; one-fourth, one-half, one, two, four, and six minutes. Intensities of insonation were observed in terms of radio-frequency energy produced at the power tubes of the generator and were approximately 40, 160, 260 and 390 volt-amperes. Extraction was increased by insonation and was proportional to time and intensity. Comparison was made with samples subjected only to mechanical agitation and thermal energy. At maximum intensity insonation, 390 volt-amperes for six minutes, extraction was about 2.7 times greater than extraction accomplished in a control sample. Increased extraction was attributed to (1) dispersion of adhered particles of feed, (2) partial disruption of oil cells, (3) extended phase boundaries, (4) microagitation at phase boundaries, and (5) thermal effect.

21. PRESSURE DISTRIBUTION ABOUT DIAMOND AIRFOILS IN A TWO-DIMENSIONAL INCOMPRESSIBLE FLOW.

Fred W. Martin; *Virginia Polytechnic Institute*.

In recent years considerable work has been done on diamond-shaped bodies in supersonic and transonic flow. For the most part, however, the theoretical analysis used considers the characteristics of the flow and utilizes the Hodograph Transformation. Although this type of investigation lends itself readily to the high transonic range, it is not applicable to the sub-critical subsonic range. On the other hand, the general solution for any body in a subsonic compressible flow utilizes the incompressible pressure distribution, which is corrected for compressibility by the Prandtl-Glauert method, Karman-Tsien method, or by some similar method. Nowhere in the literature, however, is there evidence of a solution for the pressure distribution over a diamond profile in an incompressible fluid; and consequently, there is no known solution for a diamond profile in a subsonic compressible flow.

In this paper the solution of the incompressible pressure distribution for double-wedge profiles is obtained by making use of the mapping theorem of Schwarz and Christoffel. The analytical results are given for the sym-

metric case, and these results are compared with the experimental results obtained in the VPI wind tunnel.

22. PRINCIPAL STRESS TRAJECTORIES IN GEAR TEETH.

E. D. Harrison; *Virginia Polytechnic Institute.*

The Lewis' equation is the basic standard for the design of gear teeth. This formula involves, in addition to the strength of the gear material, several dimensions based on the geometry of the tooth. Assumptions regarding loading, stress concentrations, tooth deflection and the assumed tooth form are made. By substituting in the basic equation, a value of allowable stress for the material used is determined experimentally.

This paper demonstrates a method of accurately approximating the actual stress gradients by the application of photoelastic techniques. The knowledge of these gradients makes unnecessary the determination of stress concentration factors and furnishes accurate tooth hardening information.

Values of the difference of the principal stresses at each of a network's grid nodes are determined from photoelastic information. The sum of the principal stresses is determined at each of the same points by establishing boundary conditions and applying an iteration process to the Laplace differential equation for the sum of the stresses.

Values of the principal stresses at each node can be determined and smooth stress contours and gradients drawn. A study of their relation to the "difference of the principal stress" gradients permits approximate sketching of principal stress gradients for other cases.

23. COUNTERCURRENT FLOW OF TWO-PASE LIQUID-LIQUID SYSTEMS.

Nelson F. Murphy and John E. Lastovica, Jr.; *Virginia Polytechnic Institute.*

So-called counter-current flow of fluids was demonstrated in a horizontal tube of rectangular cross-section with glass walls. Moving pictures taken through the walls of a dye stream introduced into the phases show that at high differential velocities, the phases move in the same direction at the interface. There is a plane of zero velocity (relative to the walls) which moves up and down depending on the relative velocities and densities of the phases. The significance of this behavior is discussed relative to the two-film mass transfer theory and to the variation of mass transfer coefficients in liquid-liquid extraction.

24. EFFECT OF A 400-KILOCYCLE INSONATION ON THE EXTRACTION OF ACETONE FROM CARBON TETRACHLORIDE WITH WATER.

Dudley Thompson and L. P. Murray, Jr.; *Virginia Polytechnic Institute.*

The purpose of this investigation was to evaluate a liquid-liquid extraction unit incorporating 400-kilocycle insonation and to study the effect of the ultrasonic field on the rate of mass transfer. Acetone was extracted from a feed containing 13.78 ± 2.72 weight per cent acetone in carbon

tetrachloride (saturated with water) using water as the solvent. A single-contact, continuous-flow extractor was used. Variables investigated were: solvent-to-feed ratio, flow rate, and intensity of insonation. Rate of acetone extraction was increased by ultrasonic insonation. An increase in stage efficiency of the extractor was observed when the system was insonated at 400 kilocycles with an intensity that exceeded 100 milliamperes plate current, regardless of solvent-to-feed ratio. The increase was only apparent when the total flow rate of extract and raffinate phases was greater than 32 grams per minute. Maximum increase in stage efficiency of 21.8 per cent, from 75.1 to 96.9 per cent, resulted with a solvent-to-feed ratio of 1:3 (on a weight basis) and a total flow rate of 120 grams per minute when the system was insonated at 200 milliamperes plate current. Bulk agitation and microagitation at the solvent-feed interfacial boundary aided extraction by increasing the effective area available for mass transfer.

25. LOW COST STUDY OF SUPERSONIC FLOW.

David P. Lalor with James E. May and E. C. McClintock; *University of Virginia.*

Most high-speed aerodynamic model testing is now done in small, costly wind tunnels, each one restricted to a narrow range of transonic or supersonic velocities. Instructional uses, however, demand inexpensive and extremely flexible test apparatus. The water table, a relatively new device for supplementing wind tunnel studies, meets these requirements by utilizing the "hydraulic analogy" (and also makes possible investigation of acceleration and deceleration). Specifically, wave height and standing depth relationships are considered as directly analogous to those of local air density and air stream density.

Under construction at the University of Virginia is a student-designed and built table 25 x 4 feet, holding $\frac{1}{4}$ to $1\frac{1}{2}$ inches of water. Two-dimensional models up to two feet in length are towed at relatively low velocities; sonic conditions can be simulated at speeds of less than one foot per second in $\frac{1}{4}$ " of water. To determine pressure distribution, wave heights are measured either photographically or electronically.

The water table is an excellent undergraduate project. For \$200 and 100 student hours, an accurate, practical piece of equipment for high-speed flow study and research can be developed. Also, meeting the problems of design and construction is an educational experience for prospective engineers.

26. EFFECT OF SEED STRUCTURE ON THE EXTRACTION OF OIL FROM TOBACCO SEED.

Jesse M. Carr and Robert A. Fisher; *Virginia Polytechnic Institute.*

Tobacco seed were crushed in a differential roll mill with a roll gap of 0.005 inch. The seed crushed either had their seed coat intact or removed by scarification, accomplished by use of a saturated sulphuric

acid-potassium dichromate solution. The oil yield from the seed crushed with their seed coat intact was compared with that of seed which had the seed coat removed. The seed samples were extracted in a continuous-flow extractor using trichloroethylene, isopropyl alcohol, normal hexane, and petroleum ether.

Sections of tobacco seed after extraction were compared microscopically with seed sections that had not been extracted. Sections of seed in various stages of extraction were also studied. All sections before being studied were stained with Sudan IV, a selective stain for oil droplets in tissue.

It was found, both on microscopic examination of seed sections and on comparison of oil yields, that the seed coat was the principal resistance in all cases. The removal of the seed coat increased the oil yield 6.8% for normal hexane and 10.8% for petroleum ether.

MINUTES OF THE SECTION OF GEOLOGY [8]

WAYNE E. MOORE, *Chairman*

WILLIAM T. HARNISBERGER, *Vice-Chairman*

MARCELLUS H. STOW, *Secretary*

W. D. LOWRY, *Section Editor (1958)*

FRIDAY, MAY 7, 1954—9:00 A.M.—ROOM 303, BROOKS MUSEUM

1. SOME CURRENT ACTIVITIES AND PROJECTS OF THE VIRGINIA GEOLOGICAL SURVEY.*

William M. McGill; *Virginia Geological Survey.*

The main activities and projects of the State Geological Survey for the past year and those now in progress or planned for the next year are reviewed together with a listing of publications recently issued, in press, or scheduled for publication in the next fiscal year.

2. INFOLDED METASEDIMENTALS NEAR THE AXIAL ZONE OF THE CATOCTIN MOUNTAIN-BLUE RIDGE ANTICLINORIUM IN VIRGINIA.*

Edwin O. Gooch; *Virginia Geological Survey.*

A belt of metasedimentary rocks about 60 miles long and from half a mile to two miles wide occurs in the northwestern Piedmont of Virginia, near the axial zone of the Catoctin Mountain-Blue Ridge anticlinorium, the core of which is composed of a complex of granitoid and gneissoid rocks. This complex is overlain in the eastern limb of the anticlinorium by the Lynchburg formation and by the Swift Run formation in the western limb. The writer interprets the belt of metasedimentary rocks as a series of two large and two very small infolds in the basement complex. The infolds are isoclinal and overturned towards the northwest in the southern part of the structure but are more open in the northern part. In places reverse faults cut the folds.

The rocks of the Lynchburg and Swift Run formations and the metasedimentary rocks were derived from the basement complex. Recent theories are that the Lynchburg formation overlaps the basement complex from east to west and that the Swift Run represents the thinned western edge of the overlap. Thus the Lynchburg and Swift Run formations are considered to be equivalent. Geographically, the belt of metasedimentary rocks is about halfway between the Lynchburg formation on the east and the Swift Run formation on the west. The writer correlates the metasedimentary rocks with the Lynchburg-Swift Run formation.

* Presented with the permission of the State Geologist of Virginia.

3. CAVITY FILLINGS OF RED LIMESTONE IN THE ORDOVICIAN, AUGUSTA COUNTY, VIRGINIA.

An inactive quarry, four miles southwest of Staunton and half a mile east of the intersection of U. S. Highway 11 and State Road 624, contains brecciated New Market and Lincolnshire limestones. The matrix of the breccia and the associated cavity fillings is red limestone.

In some of the cavity fillings are pellets of white clay, illite. Other insoluble minerals identified in the matrix are detrital quartz, small needle-like crystals of authigenic (?) feldspar, magnetite, pyrite, hematite, and limonite. The red color is due to iron oxides, derived from magnetite and pyrite, which fill interstices between carbonate grains and minute fractures.

It is thought that the clastic materials were derived from a soil mantle and deposited in the cavities by carbonate-rich waters.

4. *Arthrophycus* AS A GUIDE FOSSIL IN NORTHERN VIRGINIA.*

Robert S. Young; *Virginia Geological Survey*.

In the course of field investigations in the Edinburg, Virginia-West Virginia quadrangle, "worm trails" identical with *Arthrophycus alleghanensis* (Harlan) were noted in the Keefer sandstone of middle Niagaran age. Previously recorded occurrences of this form in Virginia and West Virginia have been restricted to the Clinch-Tuscarora sandstone, of Albion age and the Massanutten sandstone, the age of which is uncertain. With the Keefer occurrence, the index value of *Arthrophycus alleghanensis* is either greatly reduced or completely nullified. It would appear that this form is a facies fossil restricted to the relatively clean sandstones of the Lower and lower Middle Silurian.

On the basis of the known occurrences of *Arthrophycus* in these three formations of very similar lithology, it is suggested that the Massanutten sandstone is the direct eastern equivalent of the Tuscarora and Clinton (Rose Hill and Keefer) of the Great North Mountain section in western Shenandoah County. If this correlation is valid, the Massanutten sandstone occupies the time interval of the Albion and lower Niagaran. This time span also represents the stratigraphic range of *Arthrophycus alleghanensis*.

5. GEOLOGICAL SECTION ALONG ROANOKE RIVER FROM CLARKSVILLE, VIRGINIA TO ROANOKE RAPIDS, NORTH CAROLINA.

Wilbur A. Nelson; *University of Virginia*.

This geological section is composed of a series of folded pre-Cambrian schists, phyllites, slates, volcanics, gneisses, and granites, dipping almost vertically, and striking slightly east of north, almost at right angles across the Roanoke River. Two post-Paleozoic granite batholiths, or stocks, have been intruded, one at Buggs Island and the other near Roanoke Rapids. Eight thousand feet downstream from Eaton's Ferry, North Carolina, there

* Presented with the permission of the State Geologist of Virginia.

occurs a sequence of rocks which is interpreted as follows. A coarse pre-Cambrian granite, which is considered equivalent to the Lovingston formation, is overlain by a 1000-foot thick thoroughly metamorphosed conglomerate. The conglomerate is considered equivalent to the Rockfish formation, and, in turn, is overlain by a thick series of quartz mica schists with pegmatitic injections. This series is considered equivalent to the Lynchburg formation, and is overlain by a thick series of volcanics correlated with the Swift Run formation. This sequence is repeated to the west in reverse order. The coarse pre-Cambrian granite is considered to occupy the crest of a compressed anticlinal fold.

6. DISPLAY OF GEIGER COUNTERS AND ULTRAVIOLET LAMPS.

Marcellus H. Stow; *Washington and Lee University*.

The following instruments used for the detection of radioactivity were demonstrated:

The model SU-7 Geiger counter manufactured by Tracerlab Corporation.

The model SM-3 Geiger Counter manufactured by El Tronics Company.

The model 600-A Geiger counter manufactured by Minerals Engineering Company.

In addition to the above radiometric instruments, a short-wave and a long-wave ultraviolet lamp in field case, manufactured by Ultra-Violet Products Company, were demonstrated.

7. GEOLOGY OF URANIUM DEPOSITS WITH SPECIAL REFERENCE TO THE GEOLOGY OF VIRGINIA.

Donald L. Everhart; *Atomic Energy Commission*.

The fast-growing science of uranium geology and exploration techniques has reached a stage at which the major types of uranium ore deposits in many parts of North and South America, Europe, Africa, and Australia have been classified and studied in considerable detail. Progress has been made in our understanding of uranium geochemistry.

Twenty-seven distinct types of uranium ore deposits are recognized, of which nine include all the important present producers in the Western World.

The Commonwealth of Virginia is underlain by a number of rock types and contains a number of metalliferous deposits that appear, by our experience to date, to be favorable for uranium deposition. The A.E.C.'s geologic staff is interested in discussing uranium-ore criteria with the geologists and prospectors of Virginia and in co-operating in the examination and evaluation of favorable areas if they warrant it.

Particularly favorable geologic environments include continental conglomerate, arkosic sandstone, or mudstone formations, especially those high in carbonized plant matter, and equivalent metaconglomerate, quartzite, schists, or paragneiss formations. Three hydrothermal deposits which are favorable are: siliceous veins carrying pyrite and galena, siliceous veins rich in titanium, and nickel-cobalt-copper-silver veins.

8. THE MASTER'S DEGREE IN GEOLOGY.

Joseph K. Roberts; *University of Virginia.*

A brief study of requirements for the master's degree in America has brought out several interesting practices in 18 selected institutions of higher learning. The master's degree is the teacher's degree. The training for this degree should be broad and cultural, yet at the same time specific and scientific. The requirements below the graduate level must be the physical and biological sciences. The average master's curriculum involves about 30 hours with or without a thesis. The average time of required residence is one academic session, but the candidate usually takes more time. A degree without a thesis requires more course work. Nearly all the institutions contacted require French or German or some other language which may be used by the student in graduate work. One university even allows ancient language. The master's final examinations may be written and/or oral, and the thesis may call for a defensive examination. No thesis is required at Harvard, Yale, Chicago, or Stanford. The thesis problem may involve field work, and/or laboratory investigation, and/or research in the library. Both M.A. and M.S. degrees are given. Usually the M.A. follows a B.A. and the M.S., a B.S. Most schools of higher learning seem to hold the master's degree in healthy esteem and are inclined somewhat toward the Master of Arts.

9. STUDIES OF STREAM PROFILES IN THE SHENANDOAH VALLEY, VIRGINIA.

John T. Hack; *U. S. Geological Survey.*

Studies made primarily in Augusta County, Virginia, have furnished data that permit an empirical analysis of some of the factors that control the form of the longitudinal profiles of streams. They indicate that channel slope decreases downstream as a function of the increase in length and drainage area. The slope and the rate of decrease in slope, however, are strongly affected by the particle size of material in the stream bed and are also affected by the shape of the channel.

The size of the bed material is determined by several factors including the initial difference in elevation between two points on a stream, the rate of wastage of interstream areas by weathering, and the resistance of the transported material to abrasion and breakage. Most streams originating in the limestone and shale regions exhibit a marked increase in size of material on the bed in a downstream direction. Streams in the Devonian sandstone areas to the west of the limestone floor of the Shenandoah Valley transport very coarse material but show very little change in size of bed material downstream. Some streams which enter the limestone area from the sandstone area to the west show a decrease in the size of bed material downstream from the point of entry.

10. SOIL MINERALOGICAL STUDIES IN THE MIDDLE RIVER BASIN OF VIRGINIA.

Dorothy Carroll; *U. S. Geological Survey.*

The Middle River drains an area of limestone, dolomite, sandstone, and shale in Augusta County, Virginia. Alluvial material along the Middle River and its tributaries has been derived by the erosion of residual soils developed from these rocks. The residual soils may show a well-developed podzolic profile or be skeletal and thin.

The minerals of the insoluble residue of parent rocks were determined microscopically. The limestone contained very few heavy minerals but the shale and sandstone yielded distinctive though restricted suites. Mechanical analysis of the soils was made by the standard pipette method, and the fine and very fine sand was examined microscopically. The soils contain much silt. The pH and the ion-exchange capacity were determined. A partial chemical analysis was made of a Frederick silt loam profile on Lenoir limestone of Middle Ordovician age.

The insoluble minerals of the rocks were found in the soils; the varietal features of zircon and tourmaline were used for identification of the heavy mineral suites. Feldspars were common in some soils. The mineral suites of alluvial soils showed mixed origin except where streams were draining only one rock type. The influence of the sandstone of the Conococheague is recognized by the presence of well-rounded grains and by tourmaline with authigenic outgrowths. The sandstone of the Chemung formation of Devonian age has contributed several varieties of zircon and parti-colored tourmaline.

11. INVESTIGATION OF ALLUVIAL CLAYS IN THE SHENANDOAH VALLEY.

John C. Hathaway; *U. S. Geological Survey.*

The clay-mineral compositions of several samples of alluvial material and source-area soils of the Middle River drainage basin of the Shenandoah Valley have been determined. Vermiculite-, mica-, and kaolin-type clay minerals occur in variable amounts. Parent material shows less influence on clay-mineral composition than does degree of weathering as suggested by position of the samples in soil profiles.

Vermiculitic clay of a mixed-layer character, possibly interstratified with chlorite and mica layers, seems to increase in importance with weathering. A decrease in hydrous mica usually accompanies the increase in vermiculite. The kaolin minerals exhibit the least change.

12. CLAY MINERALS IN TATUM SILT LOAM SOIL.

C. I. Rich; *Virginia Agricultural Experiment Station.*

Tatum silt loam, a soil developed over Wissahickon schist, was sampled in Fauquier, Louisa, Culpeper, and Fluvanna counties of Virginia. Identification of the clay and claylike minerals was made by x-ray diffraction and differential thermal analysis. The predominant minerals found were kaolinite, illite, and dioctahedral vermiculite. Random interstratification of illite and vermiculite was apparent in samples from some localities. Gibbsite, abundant in the Culpeper sample, was not detected in some samples. Iron oxides make up about 10-20 per cent of the clay-size fraction (less than two microns). Quartz was found in the coarse clay (2-0.2

microns). Although kaolinite and vermiculite were the only clay-type minerals found in the medium and fine clay fractions, iron oxides were also present. These fractions of some samples also contained gibbsite.

The vermiculite differed in its reaction to potassium saturation. In some samples the basal spacing decreased from 14.7 to 10.2 angstroms on potassium saturation; in others the spacing decreased less. Subsoil vermiculite samples tended to collapse on potassium treatment more readily than surface samples. It is proposed that some difficulty exchangeable cation, perhaps aluminum, between the basal planes prevented saturation with potassium. Treatment of the clay fraction for 10 minutes with 1N NH₄F permitted potassium saturation and collapse of the 14.7 line to 10.2 angstroms.

13. SUBSURFACE DRAINAGE ALONG NORTH SIDE OF WALKER MOUNTAIN, VIRGINIA.*

Jean Lowry; *Virginia Geological Survey*.

Some of Virginia's largest and deepest caves occur in Middle Ordovician limestones along the north side of Walker Mountain. In this belt, the known caves contain flowing sterams whereas elsewhere in southwestern Virginia only one cave out of six is likely to have one. Several of the Walker Mountain cave streams appear to flow in a direction opposite to that of nearby surface streams.

Downdcutting by surface streams has tapped the network of phreatic cavities, opening them to vadose water which has partially removed the mud fill and deposited beds of cobbles in places. The former watertable level is well-marked in Newberry-Bane Cave at a depth of 315 feet below the entrance where the nature of the cavities shows a striking change. Above this level graded passages and large domestic occur; below, irregular rounded cavities having large cuspatate projections from floor, walls, and roof are common.

Cave streams flow like water in a pipe; they may cross over each other without meeting, or may double back under themselves. Underground waterfalls are common, especially in the domepits. Several streams may occur in a single cave. The Walker Mountain caves are ideal for further much-needed study of the behavior of underground water in limestone terrain.

14. FUNDAMENTAL PROBLEMS OF GENESIS OF APPALACHIAN DOLOMITES.

Byron N. Cooper; *Virginia Polytechnic Institute*.

Fundamental problems connected with the formation of Appalachian dolomites of Cambro-Ordovician age are reviewed in the light of ranges in chemical composition of some 235 analyses of various dolomites in the Valley region. Regional facies variations in the Cambro-Ordovician dolomites strongly suggest a northwestern source for the deposits. Median belts of the Canadian series in the Appalachian Valley show very inter-

* Presented with the permission of the State Geologist of Virginia.

esting gradations and alternations of limestone and dolomite, but observed relations of these two lithologies raise more questions about the possible sequence of events during dolomitization than they answer. None of the information obtained up to the present time can be taken to show that primary dolomite is an impossibility. At least some dolomite seems so formed by conversion of previously deposited films of calcium carbonate practically at the sea-sediment interface. The unexpected discovery that the ratio of iron to magnesium in Appalachian dolomites is virtually constant, regardless of type or location of the dolomite suggests the possibility that iron may be an essential element in the particular mineral species characterizing our Appalachian dolomites. Mineralogical and petrographic studies of dolomites, coupled with more and better chemical analyses, should provide many of the answers to the various problems of dolomite genesis.

15. STAINING METHODS FOR DIFFERENTIATING LIMESTONES AND DOLOMITES.

C. R. B. Hobbs, Jr.; *Virginia Polytechnic Institute*.

Preferential staining procedures facilitate the differentiation of calcite from dolomite in magnesium-bearing limestones. Mineral composition and structural relationships are emphasized in relief on stained polished surfaces.

The purpose of this investigation is to determine suitable staining reagents that will permit an accurate determination of composition and structure of magnesium-bearing limestones. Because of a difference in the mineral composition and grain size of the specimens, the reaction time and reagent concentration are not critical. Two unlike specimens treated with reagents of the same concentration for the same length of time will stain with dissimilar intensity. Stains are developed the same way that photographs are developed.

After considering staining techniques described in available literature (ferric chloride, logwood dye, silver nitrate, copper nitrate, cobalt nitrate, and alizarine red), the writer concludes that potassium ferricyanide and a modification of the logwood dye are most satisfactory. Rhodamine B, which is substituted for logwood dye, stains calcite pink; potassium ferri-cyanide stains dolomite powder blue. Potassium ferricyanide stains dolomite only if iron is present; therefore, in the absence of iron, rhodamine B is used to stain calcite. The malachite green oxalate staining method may be substituted for the rhodamine B procedure.

16. SELECTIVE OBLITERATION OF FOSSILS BY DOLOMITIZATION.

Wayne E. Moore; *Virginia Polytechnic Institute*.

The Suwannee limestone of Florida is composed of beds of limestone, partially dolomitized limestone, and dolomite. The dolomitization of the limestone appears to be a secondary feature of the rock. As a limestone bed in this formation is dolomitized, the fossils are selectively eliminated from the rock by solution and by dolomitization.

Prior to dolomitization those shells that contain appreciable amounts of aragonite are dissolved from the rock by ground water. *Pecten*, *Ostrea*, Foraminifera, and echinoids are not removed by solution. As dolomitization takes place, scattered rhombs of dolomite develop in the rock and in the shells of the fossils not previously removed by solution. These rhombs of dolomite replace the calcite of the shell walls and destroy the organic structure of the shell. Foraminifera are among the first and echinoids are among the last to be dolomitized. Where dolomitization of this type occurs, the finer sedimentary structures of the rock are destroyed, and no evidence remains to indicate that the rock was once fossiliferous.

17. PRE-LITHIFICATION FEATURES OF SOME CAMBRO-ORDOVICIAN MAGNESIAN AND DOLOMitic LIMESTONES OF SOUTHWESTERN VIRGINIA.

W. D. Lowry; *Virginia Polytechnic Institute*.

Primary and other pre-lithification features include bedding, cross-bedding, ripplemarks, fossils, siliceous layers and nodules, stylolites, and slump faults. Excluded are fracture fillings of silica with dolomolds and mineralization along major faults. Primary features of the completely dolomitized Knox limestones are generally not well preserved and the only fossils are silicified.

The partial dolomitization of Chepultepec limestone in the Virginia Polytechnic Institute quarry near Blacksburg occurred after slumping but before lithification. The surfaces of slump faults are stylolites developed as solution permitted the walls to interlock. These stylolites and numerous ones along the bedding consist of grains of pyrite and aggregates of relatively coarse-grained dolomite. The sutured texture of these aggregates is characteristic of the dolomitic limestones and largely the result of interference during growth. Pressure solution at grain contacts may complete suturing and destroy permeability. Dolomitization, although not primary, may proceed so long as permeability exists and may not be interrupted until lithification is nearly complete. Incomplete dolomitization of Chepultepec and Longview limestones is attributed to originally low permeability. Partial dolomitization might result from expulsion of poor water, but complete dolomitization requires circulating magnesium-bearing solutions. A reducing environment may favor formation of pyrite and dolomite while calcite is being dissolved.

18. POSSIBLE TRACE-ELEMENT AND/OR ISOTOPE CONTROL OF DOLOMITE FORMATION.

R. V. Dietrich; *Virginia Polytechnic Institute*.

All elements recorded to be present in dolomites and in natural solutions generally believed to be representative of the solutions from which dolomite may have been precipitated are listed. The known natural isotopes of each of these elements are reviewed.

It is emphasized that formation of dolomite, whether it be by precipitation or by replacement (either volumetric or molecular), must be in accordance with the laws of physical chemistry. It is suggested that relatively

minor upset(s) of elemental and/or isotopic abundances within the solutions from which the dolomite was derived may have promoted its formation.

A number of questions are posed with the hope that they may initiate investigations that will lead to understanding of the mode(s) of dolomite formation. Representative questions are: 1. Can precipitation of dolomite be controlled by amount(s) of some trace element(s), *e.g.*, strontium, in the solutions from which the dolomite was deposited? 2. Can the formation of dolomite be promoted by a relative concentration of some isotope(s), *e.g.*, a concentration of deuterium (as D₂O and/or HDO) such as is known to occur locally (because of selective evaporation) in environments believed to be similar to those in which at least some dolomite has been formed in the past?

19. DEPOSITION OF CALCITE AND ARAGONITE IN CAVES.

John W. Murray; *Virginia Polytechnic Institute*.

Cave deposits, such as stalactites, stalagmites, and helictites are commonly composed of calcite and less commonly of aragonite, two of the polymorphic forms of calcium carbonate. This investigation was undertaken to determine what factors control the identity of the mineral deposit-ed.

Chemical analyses were made of numerous samples of water dripping from stalactites of each of these minerals and of samples of the deposits themselves. All samples were taken from Canoe and New River caves, Giles County, Virginia.

In one laboratory experiment, calcium carbonate was precipitated in test tubes by allowing carbon dioxide to escape from solutions of calcium bicarbonate to which various salts had been added. In another experiment stalactites were grown under controlled conditions and the effect of composition of the water on the minerals formed was studied.

From these experiments, it may be concluded that the presence of sufficient magnesium, strontium, or lead favors the formation of aragonite as does high temperature and low concentration of calcium bicarbonate. These factors may be influenced by physical conditions such as rate of flow of water onto the surface, area of the surface, and relative humidity. Concentration of magnesium seems to be the factor most likely to be effective in controlling the mineralogical identity of the calcium carbonate of cave deposits.

20. GEOLOGY OF THE AUSTINVILLE DISTRICT, VIRGINIA.

W. Horatio Brown; *New Jersey Zinc Co., Bertha Mineral Division*.

Austinville, which in early days was known as "The Lead Mine," may be aptly described as "The Arsenal of Virginia." It has supplied lead for our armies in every war the country has fought, starting with the French and Indian War. It is regarded by the writer as the most historic town west of the Blue Ridge in Virginia. It has been the capitol of the North-

west territory, the site of the signing of the first Declaration of Independence and the target of enemy action in three wars.

The Austinville Mine, to which the town owes its being, was operated on residual lead ore in clay in the early days. In recent years the mine has been operating on sulphide ores of zinc and lead which occur in brecciated Shady Dolomite. These breccia ore bodies occur parallel with strike faults and are enlarged at cross-fault intersections. They are regarded as being of low temperature magmatic origin.

21. ELECTRICAL RESISTIVITY AND MAGNETIC SURVEY OF THE BUSH-HUTCHINS ILMENITE DEPOSIT, VINTON, VIRGINIA.

Charles E. Sears, Jr.; *Virginia Polytechnic Institute*.

The Bush-Hutchins ilmenite deposit is near the junction of State Highways 24 and 654, approximately 1.8 miles east of Vinton in Roanoke County, Virginia.

Geophysical work (a magnetometer survey) was first done in this area by the Division of Geophysical Exploration of the U. S. Bureau of Mines in 1946. The results of the survey were published in U. S. Bur. Mines Rept. Inv. 4112, August 1947. The present report gives the results of an electrical resistivity and Hotchkiss Super-dip survey made during the spring of 1954 under the supervision of the writer.

Electrical resistivity and magnetic anomalies were obtained along the strike of the investigated deposit. The results of the geophysical work thus far completed point to tabular bodies which strike approximately N. 50° E. and dip steeply to the northwest. Further work is necessary to outline the limits of these bodies along the strike and down the dip.

22. A PREVIEW OF RECENT LITERATURE ON THE GEOLOGY AND ORIGIN OF PEGMATITES.*

Arthur A. Pegau; *Virginia Geological Survey*.

Theories which concern pegmatites and which are based on studies made during the past few years may be classified into three categories: zonation, emplacement, and replacement. Increasing emphasis has been placed on the zoning or structure of pegmatites. This zonation is three dimensional and extends from the outside to the center of the pegmatite body. An outer zone, an intermediate zone, and a medial zone or core are generally recognized.

Recently structural control of the emplacement of pegmatites has received considerable attention. The structural features in igneous rocks that control the emplacement of pegmatites include primary layering and other planar structures. The features in metamorphic rocks that control emplacement include bedding, foliation and schistosity. Fractures in both kinds of rock may control emplacement. Although replacement in pegmatite bodies has been recognized as important for many years, it has been given much greater emphasis in recent years.

* Presented with the permission of the State Geologist of Virginia.

Current theories regarding the origin of pegmatites do not differ greatly from those held for the past twenty years. This is surprising in view of the fact that the theories advanced for the origin of some plutonic rocks have undergone such material changes in the past ten years. In other words, most writers still consider that pegmatites are essentially of magmatic origin rather than a product of metasomatic replacement.

23. EXPLORATORY DRILLING ON THE EASTERN SHORE PENINSULA, VIRGINIA.

G. C. Tibbitts, Jr.; *U. S. Geological Survey.*

In the summer of 1953, four test wells were drilled by the hydraulic rotary method on the Eastern Shore peninsula. These wells are on a 55-mile line extending north-northeast from Capeville, on the southern tip of the peninsula, to Oak Hall near the Maryland boundary. Their depths are 470, 100, 450 and 451 feet; three wells penetrate the Middle Miocene.

Samples were collected at 5-foot intervals, and Schlumberger electric logs were run in each hole. The electric, lithologic, and driller's logs show a remarkable correlation between the wells.

All drill cuttings were washed in a 150-mesh screen, floated in carbon tetrachloride, and the floats sent to the U. S. National Museum for foraminiferal studies. According to Miss Ruth Todd of the Museum, the wells penetrate the Miocene at 65, 90, 125, and 115 feet from south to north. Only one well contained a Pleistocene fauna. That fauna is characteristic of a cold water environment similar to that found today from New England to the Arctic. The Miocene assemblages are typical of a shallow marine environment open to ocean currents.

Good water-bearing zones were encountered above 200 feet. Below this depth, ground water occurs only in thin aquifers of relatively low yield and it is likely to be too highly mineralized for ordinary uses.

24. HEAVY MINERALS OF SOME YORKTOWN SEDIMENTS OF VIRGINIA.

Albert J. Perry, David W. McGain, and J. Scott Laurent; *Washington and Lee University.*

Microscopic study of heavy mineral separates of samples collected from seven sections of the Yorktown formation of Miocene age on the York and James Rivers showed striking similarity in the minerals present and their relative abundance. Correlation of these sections was possible by a combined lithologic and heavy mineral study. The sediments were determined to have been derived from crystalline rocks, and the sources of the sediments and their conditions of deposition were found to be the same throughout.

25. MINERAL STUDIES OF THE PRODUCT OF SOME VIRGINIA QUARRIES.

Eugene B. Sieminski, Bertram S. Griffith, Jr., and Mahlon D. Woodring; *Washington and Lee University.*

Samples of screenings from seven quarries in granitic rocks of the Vir-

ginia Piedmont were collected for mineral studies. These were examined to determine the percentages of heavy minerals, light minerals, quartz, and feldspars. The study indicates that the feldspar content of these granitic rocks is appreciably higher than the feldspar content found in quartzites which may have a false appearance of being granitic. These determinations may be important in classifying the rocks of quarries for tax amortization purposes.

26. FUNDAMENTALS OF CRUSTAL MEGASHEARING AND NOTES ON THE FOUR TYPES OF MEGASHEARS IN VIRGINIA.

B. Ashton Keith; Director; *The Institute of Sciences.*

These investigations, which have begun to attract international attention, are based upon certain discoveries made in the 1850's by G. A. Daubree. Daubree's laboratory tests on the effects of various force-sets in the shearing of rocks and various other substances established knowledge that now is used in all schools of engineering. Attention is called especially to Daubree's discovery that many shear zones really consist of a series of roughly aligned minor distortions that are diverse in form or orientation or both. He also found that when rocks and minerals are subjected to excessive torsional stress, two sets or systems of fractures are formed and that the fractures of one set form angles of approximately ninety degrees to the fractures of the other set. Daubree applied his findings to the investigation of similar structures in nature such as joints and cleavage. He also identified "giant joints", which he believed cause the right-angle bends in many large rivers and in some places exert noticeable influence upon other elements of topography. Hartmann and others confirmed Daubree's findings, and Becker and others submitted them to mathematical treatment.

In 1903 my investigations began with discovery of a long aligned arrangement of deep-seated structures. Investigations were made of the important effects of non-parallel, non-coplanar force-sets which have been found to affect the earth's crustal shell. This paper names the classes and systems of megashears, describes their component segments, and demonstrates examples of each of the types that have been found in this region.

27. WHAT IS THE BEHAVIOR OF MAJOR APPALACHIAN OVERTHRUSTS AT DEPTH?*

Ralph L. Miller; *U. S. Geological Survey.*

Recent geologic studies in Lee and Scott Counties of southwestern Virginia revealed interrelations of several major overthrust faults and numerous minor surface and near-surface faults. Projecting the faults downward involves much speculation and raises fundamental questions concerning the mechanics of deformation in this region. These questions are: 1. Do the major thrusts continue downward and transect the basement rocks not far southeast of their traces or do the major faults merge above

* Publication authorized by the Director, U. S. Geological Survey; paper not presented at meeting.

the basement rocks and continue above the basement for many miles southeast of their surface locations? 2. In general, were the southeastern major overthrusts formed first and followed by a wave of compression and thrusting that progressed northwestward or did one or a few major sheets of super-basement rocks move as units along nearly flat thrust planes early in the orogeny, and then become ruptured by additional large and small faults as deformation progressed?

Although the solution to these basic questions may be attained only by deep drilling in critical locations, geophysical methods might give partial answers. An airborne magnetic survey of this region is being made by the U. S. Geological Survey, and evidence may be obtained regarding the configuration and position of the top of the basement rocks.

28. AN OCCURRENCE OF ZEOLITES IN FAIRFAX COUNTY, VIRGINIA.*

William T. Parrott; *Virginia Department of Highways*.

An uncommon assemblage of zeolites was exposed in a cavity in the dia-base of the Fairfax Stone Co. quarry as a result of blasting during the summer of 1953. The quarry is on the east side of State Highway 211, about 1.5 miles south of Centreville, Virginia.

Specimens were collected by both the Geological Survey and the U. S. National Museum. The quarry owner, Mr. Charles Luck, presented the writer with specimens. These were identified by the Geological Survey as the following zeolites:

Thaumasite $\text{CaSiO}_3 \cdot \text{CaCO}_3 \cdot \text{CaSO}_4 \cdot 15 \text{H}_2\text{O}$, hexagonal

Prehnite $\text{H}_2\text{Ca}_2\text{Al}_2(\text{SiO}_4)_3$, orthorhombic

Natrolite $\text{Na}_2\text{Al}_2\text{Si}_3\text{O}_{10} \cdot 2\text{H}_2\text{O}$, orthorhombic

The fibrous natrolite and large crystals of thaumasite were on a mass of prehnite.

So far as the writer can ascertain, the occurrence of thaumasite in Virginia has been mentioned only once in the literature.

BUSINESS MEETING

At the close of the technical session, which was attended by about sixty geologists, it was moved and passed that those members who wish to have their abstracts included in "Geological Abstracts", published by the American Geological Institute, should so inform the Section Editor. Discussion of the type of program that should be presented at the annual meeting of the Section showed a wide divergence of opinion.

The nominating committee placed the following names in nomination for section offices. All were unanimously elected.

Chairman--William T. Harnsberger

Vice-Chairman--William T. Parrott

Secretary--Marcellus H. Stow

Section Editor--W. D. Lowry

The meeting was adjourned at 5:00 P.M.

* Paper not presented at meeting.

FIELD TRIP

A caravan of seventeen cars with fifty-three geologists left the Rivanna River Bridge at 8:00 A.M. on May 8, 1954, under the leadership of Joseph K. Roberts and Raymond S. Edmundson. The purpose of the trip was to study areas of Triassic rocks in northern Virginia. The itinerary included Triassic lowlands north of Orange, diabase monadnocks in the vicinity of Cedar Mountains, red sandstone and fresh-water oolitic limestone in the State Highway quarry near Winston, and the large diabase quarry of the Fairfax Stone Company near Centreville. Various zeolites and associated minerals were collected at the Fairfax Stone quarry. The next stop was at the Goose Creek quarry, near Herndon, where exposures of gabbro and diabase were examined. At another quarry in the same vicinity along State Highway 7, rocks of undetermined origin were inspected. The final stop was made north of Leesburg at a grand exposure of the famous "Potomac Marble," a Triassic limestone-conglomerate.

At this point most of the members of the group left for their respective communities after a most enjoyable day in the field under most competent and congenial guidance.

MINUTES OF THE SECTION OF MEDICAL SCIENCES [9]

D. R. H. GOURLEY, *Chairman*

SIDNEY SOLOMON, *Secretary*

EBBE C. HOFF, *Section Editor (1955)*

FRIDAY, MAY 7, 1954—9:00 A.M.—MEDICAL SCHOOL
AUDITORIUM

1. MOTION PICTURES SHOWING NERVE GROWTH AND OTHER CELL ACTIVITIES IN TISSUE CULTURES OF RETINA AND BRAIN FROM FROG AND RAT.

C. C. Speidel; *Department of Anatomy, University of Virginia Medical School.*

These pictures of frog and rat tissues show all movements accelerated 128 times. Among the features illustrated are the following: growth of nerve fibers from ganglion cells of the retina and from nerve cells of the brain; progressive injury of rod cells characterized by transverse fragmentation (striation) and curling of the rods; movements of other cells of the retina; and the behavior of various cells of the brain of both nervous and neuroglial types. A case of mitosis and rapid post-mitotic differentiation of an oligodendrocyte is shown.

Several cine-photomicrographs illustrating the behavior of cells *in vivo* are also presented. They make interesting comparisons with some of the *in vitro* pictures. Thus, the growing nerve fibers of retina and brain in tissue cultures are quite like similar regenerating fibers from the proximal stumps of cut vagus and spinal nerves in the living tadpole's tail; the oligodendrocytes of the rat's brain are much like the neurilemma sheath cells of the peripheral nerves in living tadpoles; and certain of the microglia cells (cells of Hortega) of the rat's brain in cultures resemble the macrophages in the living tadpole's tail.

2. ON THE PRESENCE OF ARGENTOPHILIC CELLS IN THE HUMAN ADENO-HYPOPHYYSIS.

William M. Shanklin; *Medical College of Virginia.*

Cells having argentophilic properties were observed in the human adeno-hypophysis in sections stained for pituicytes by a Hortega silver carbonate method.

This study includes 84 consecutive pituitaries varying from the newborn to 9 years. All, except 16, had argentophilic cells. Ten of the negative specimens were newborn and six adult. One newborn and one six-month specimen were positive. Examination of Masson trichrome stained sections showed marked degeneration of the epithelium in three

of the pituitaries lacking argentophilic cells. Their absence in the remaining three can be attributed to overformalinization.

Argentophilic cells occurred most abundantly in the pars anterior, in some areas constituting about 30% of the total cell count, to a lesser degree in the lower pars tuberalis and in pars intermedia. The argentophilic cells were very darkly stained and stood out in sharp contrast to the unstained chromophobe and chromophil cells. They were located inside the cords of epithelial cells, and many had broad protoplasmic processes that extended to the periphery of the cord.

It has not been determined whether these cells represent the acidophils, basophils, chromophobes, or a new variety of cell.

3. EFFECT OF HORMONES ON SERUM PROTEIN PATTERNS.

Cornelia Hoch-Ligeti and Karen Irvine; *University of Virginia School of Medicine.*

Attempts were made to find the pathway leading to the changes in the serum protein composition which were observed in patients undergoing surgical operations. The serum proteins were analyzed by paper strip electrophoresis. During the first four post-operative days a consistent decrease in the relative concentration of albumin and an increase in the relative concentrations of alpha₁ and alpha₂ globulins were found. In rats similar changes in the serum protein patterns were observed after abdominal incision. Hormones and drugs acting on the autonomous nervous system were tested in rats for their effect on the serum proteins. The only substance which was found to produce an alteration in the protein pattern similar to that found post-operatively was the adreno-corticotrophic hormone (ACTH) of the pituitary. Since both cortisone and desoxycorticosterone were ineffective after short term administration, it appears that ACTH influences the serum protein composition through a substance other than the adrenal cortical hormones thus far tested.

4. CHEMICAL AND ULTRACENTRIFUGAL LIPID ANALYSIS OF DIABETIC AND CARDIAC SERA.

D. F. Koenig, P. D. Camp, W. R. Jordan, J. C. Forbes, C. J. Likes; *Virginia Institute for Scientific Research and Medical College of Virginia.*

A technique of analysing sera for free and loosely-bound cholesterol, and the Gofman ultracentrifugal procedure for lipoprotein analysis, are briefly described. Results of combined studies of "readily-extractable" cholesterol and various lipoprotein fractions, in diabetic and cardiac sera, are discussed.

5. THE ROLE OF THE ADRENAL GLANDS IN THE SUPPORT OF ARTERIAL BLOOD PRESSURE IN DOGS AND CATS FOLLOWING EXTENSIVE SURGERY.

E. D. Brand; *University of Virginia School of Medicine.*

Following extensive surgery the arterial blood pressure of 18 dogs and

5 cats ranged from 70 to 125 mm Hg. Clamping of the blood supply to one adrenal gland was without consistent effect, but when the pedicle of the remaining adrenal was clamped the arterial pressure fell precipitously to a new level ranging from 35 to 100 mm Hg, and remained at this level or dropped slowly until the death of the animal. If one or both clamps were removed however, there was a rapid rise in blood pressure of from 20 to 120 mm Hg with a subsequent leveling off at or somewhat below the reading present prior to the clamping. This effect was blocked by the administration of the adrenolytic agent dibenzyline (2-4 mg./kg. i.v.). Control clamping of the spleen, kidneys, or of the vena cava distal to the adrenal veins was without effect on the arterial blood pressure as was administration of cortisone or hydrocortisone (12.5 mg./kg., i.v.).

6. A THEORY OF THYROXINE ACTION.

Chalmers L. Gemmill; *University of Virginia School of Medicine*.

A study of the ultraviolet spectra of thyroxine and related compounds has shown that the presence of iodine causes a marked increase in the height of the bands and a movement of the maxima towards longer wave lengths. This change has been interpreted by Dr. C. Reid (Present address: Department of Chemistry, University of British Columbia, Vancouver, Canada) as a $n - \pi$ transition in which an electron under the excitation of ultraviolet radiation leaves the normal (n) state and enters the π state. This transition is aided by the presence of the heavy atoms of iodine. If a similar transition may occur under chemical activation, the electron may then pass through the whole molecule and be delivered to an electron acceptor situated at the amino acid end of the molecule. Although other theories may be presented to explain these changes in the ultraviolet spectrum, this idea has the possibility of explaining the need for certain specific parts of the thyroxine molecule essential for biological activity and for prediction of compounds of possible biological action related to thyroxine.

7. EFFECT OF ALCOHOL INTOXICATION AND ACTH ON LIVER ASCORBIC ACID IN THE GUINEA PIG.

J. C. Forbes and G. M. Duncan; *Medical College of Virginia, and the Division of Alcohol Studies and Rehabilitation, Department of Health, State of Virginia*.

Earlier work has shown that although alcohol intoxication in guinea pigs caused a marked drop in the ascorbic acid content of the adrenal glands, repeated intoxication did not lead to any acceleration of the rate of development of scurvy when the animals were on a scorbutogenic diet. It thus appeared that this particular stressor agent, at least, did not increase or accelerate the utilization of ascorbic acid by the guinea pig. In order to determine whether stress had affected the distribution of vitamin C in any other tissue in addition to the adrenals, a study was made of the content of ascorbic acid in the liver of guinea pigs at intervals for several

days following alcohol or ACTH administration. The experimental results showed that the ascorbic acid content of the liver of those animals sacrificed 24 hours after alcohol intoxication did not demonstrably differ from that of the corresponding control animals. However, 48 hours after the alcohol administration, the test animals showed a significantly higher liver ascorbic acid content than the controls. The difference 72 hours after alcohol was less but still notable. Quite comparable results were obtained with injection of adrenocorticotropic hormone, although the difference between the test and control animals developed about 24 hours earlier. The results suggest that mobilization of ascorbic acid to the liver may be a part of the adaptation process.

8. BLOOD AND URINARY CHANGES DURING ACUTE ALCOHOL INTOXICATION IN DOGS.¹

Gerda Klingman, Ruby Bane, Harry Bachman and Harvey B. Haag; *Medical College of Virginia.*

This investigation concerns the changes in blood electrolytes, pH, bicarbonate, glucose, hematocrit, hemoglobin, NPN, BUN, alcohol levels and urinary pH, electrolytes and volume when fatal or near fatal doses of alcohol were administrated orally to dogs. Unanesthetized dogs were given 25% alcohol (12 mg. 95% alcohol/Kg. to body weight) in three equal hourly dosages. For control purposes, two weeks previously the same animals received the equivalent volume of water similarly administered and the same studies done. The controls showed the expected diuresis and lowered urinary milliequivalents of K⁺, Na⁺, Cl⁻. Plasma Na⁺ and Cl⁻ showed slight variations, plasma K⁺, hematocrit, hemoglobin, NPN and BUN decreased. When these animals received alcohol they showed a transient, slight diuresis, then a marked oliguria. The urine became more acid; Na⁺ decreased more suddenly and markedly; Cl⁻ behaved essentially similar to the controls. The blood glucose, NPN, BUN, hematocrit, and hemoglobin increased; the blood pH and the plasma K⁺, Cl⁻ and Na⁺ decreased. Animals living less than 12 hours after administration of alcohol died usually of respiratory failure; longer living animals died usually of circulatory failure. The most striking effects of severe acute alcoholism in dogs is acidosis, hyperglycemia, hemoconcentration, oliguria, and elevated plasma NPN and BUN.

9. SEDATIVE-HYPNOTIC PROPERTIES OF 2-ETHYLCROTONYLUREA.

Merle H. Pindell,² Otis E. Fancher and Robert K. S. Lim; *Miles-Ames Research Lab., Elkhart, Ind.*

MA-110 (2-ethylcrotonylurea) is an almost insoluble, white crystalline compound prepared by dyhydrobromination of Carbromal. Homogenized aqueous suspensions were therefore employed for administration. MA-

¹ This work was done under a research grant from the Division of Alcohol Studies and Rehabilitation; Department of Health of the State of Virginia.

² Present Address: Dept. of Pharmacology, Medical College of Virginia, Richmond, Va.

110 has an oral LD₅₀ of 2500 mg/kg in rats, 3500 mg/kg in dogs, and an intraperitoneal LD₅₀ of 900 mg/kg in dogs, 1100 mg/kg in guinea pigs, and 1400 mg/kg in rabbits. Rats become sedated at extremely low oral doses (1% LD₅₀). Sedation occurs in 15-30 minutes and lasts several hours. At any dose up to about 48% LD₅₀ the rats are readily arousable and when aroused seem normally active. With still higher doses nervous depression (subhypnosis) progresses until hypnosis is complete at about 90% LD₅₀. Under similar conditions pentobarbital, seconal, and phenobarbital produce sedation at about 4% LD₅₀. Barbiturate sedation appears earlier but subsides faster than MA-110 sedation. Increasing this dosage to only 16% LD₅₀ produces a more profound state of depression (subhypnosis) and with doses of 35% (pentobarbital, second) and 50% (phenobarbital) hypnosis occurs. The wide range of dosage between sedation and hypnosis shown by MA-110 suggests a much greater margin of safety than with existing sedatives. Caffeine (60 mg/kg, IP) given before or after MA-110 (100-250 mg/kg, IP) does not alter its sedative effect. MA-100 produces no slowing of respiration beyond that seen in sleep and no effect on blood pressure with doses up to 80% LD₅₀ (IP) in unanesthetized dogs. It has no anticonvulsant, analgetic, or antispasmodic activity. The low sedative dose, wide sedative range, and low toxicity of MA-100 render it unique among sedatives.

10. SACRO-COCCYGEAL TUMOR.

James E. Kindred; *University of Virginia Medical School.*

The morphologic and histochemical characteristics of the tissues of a tumor from the sacrococcygeal region of a five-day old child which was removed by Dr. Shannon Allen of the Surgical Service is described, and suggestions are made as to its etiology. The tumor lay between the rectum and the coccyx, pushed the anus and rectum forward, and had a distended volume of about 200 cc. The stroma is of the usual tissues found in the ano-coccygeal region and envelops two large cysts each lined with abortive neuroglia tissue and ependyma. Several smaller cysts lined with varying kinds of stratified squamous epithelium mingled in some of them with PAS positive goblet cells are present. The epithelium is like that of the normal anal canal in part. Tentatively, it is suggested that the tumor is derived from overgrowth of cysts arising from the coccygeal vestige of the neural tube and from the epithelium of several zones of the anal canal.

11. THE USE OF A PERSISTENT SCREEN OSCILLOSCOPE FOR THE ACCURATE MEASUREMENT OF SEIZURE THRESHOLD IN RATS.

Cary G. Suter, Guy H. Heye, Jr., Thomas H. Simmons, Jr.; *University of Virginia Hospital, Charlottesville.*

12. STUDIES ON PANCREATIC TRANS-MEMBRANE POTENTIALS.

S. Solomon; *Medical College of Virginia.*

A microelectrode method has been described by which electrical potentials of pancreatic tissue may be determined. If animals are fed, the potential values in the absorptive state have either a positive or a negative sign. With 12-16 hour starved animals, the inside of the tissue is found only to be positive to the outside. If the animals be excessively starved, however, the potential sign is reversed and the inside is found to be negative. Application of pilocarpine to the gland usually results in a fall in potential difference. Treatment of fed animals of negative potential signs with acetylcholin produces a rise in potential towards zero.

13. EFFECT OF ADENOSINE TRIPHOSPHATE, MAGNESIUM AND CALCIUM ON THE PHOSPHATE UPTAKE BY RABBIT ERYTHROCYTES.

H. Jones; *University of Virginia School of Medicine.*

During the course of a series of studies on the influence of adenosine triphosphate (ATP) on the uptake of radioactive orthophosphate (P^{32}) by rabbit erythrocytes, it was found that calcium and magnesium had an effect on the uptake in the presence of ATP. The results of incubating blood with Ca^{++} with and without ATP showed distinct inhibition by the cation. When incubating blood with $3.9 \times 10^{-6} M$ Mg^{++} and $4.7 \times 10^{-6} M$ HPO_4^- and with a series of ATP concentrations ranging from $1.5 \times 10^{-16} M$ to $3.4 \times 10^{-3} M$ the P^{32} uptake was stimulated when the ATP concentration was less than $10^{-10} M$. Inhibition resulted as the ATP concentration was increased. This inhibition was strongest at $10^{-7} M$ ATP. However a second stimulation was observed when the ATP concentration exceeded $4 \times 10^{-6} M$. A study of the dissociation and solubility constants in biological fluids of $MgHPO_4$ and MgATP suggests that ATP favors the uptake of P^{32} when all ATP is complexed with Mg in the presence of an excess of either free ATP = or Mg^{++} . At concentrations unfavorable for this combination the P^{32} uptake was reduced, when it could be calculated that undissociated $MgHPO_4$ may exist in the extracellular fluid. This assumption was tested by incubating blood with $1.0 \times 10^{-14} M$ ATP, $4.0 \times 10^{-6} M$ $HP^{32}O_4$ and with a series of Mg^{++} concentrations ranging from $3.3 \times 10^{-18} M$ to $3.3 \times 10^{-6} M$. It was found that the P^{32} uptake was stimulated when the Mg^{++} concentration was less than $4 \times 10^{-13} M$, but inhibition existed at all higher concentrations of Mg^{++} . This inhibition seemed to be reversable by K^+ . A consideration of the appropriate dissociation and solubility constants for Mg induced inhibition suggests that Mg^{++} favors P^{32} uptake if almost all the Mg is complexed with ATP in the presence of free ATP =. However, inhibition seemed to be correlated with an excess of Mg^{++} over ATP and with the formation of undissociated $MgHPO_4$. There is evidence for the conclusion that the ATP-Mg complex, where ATP : Mg = 1, acts as the active component of an (ATP \rightleftharpoons ADP) — Mg — kinase — cell surface lipoprotein unit for hexose phosphorylation on the erythrocyte surface.

14. POTASSIUM ADSORPTION BY EPITHELIAL CELLS OF ISOLATED FROG SKIN.

E. G. Huf and J. P. Wills; *Medical College of Virginia.*

It appears that intracellular potassium (K_i^+) in epithelial cells of frog skin is in a state of adsorption since the amount of K_i^+ /gm of intracellular water, as a function of the extracellular (equilibrium) concentration of potassium (K_e^+) which was varied over a wide range from 0.1 – 20 $\mu\text{Eq}/\text{ml}$, follows rather closely the equation $[K_i^+] = 10^b \cdot [K_e^+]^{1-a}$. One recognizes this as a special form of Freundlich's general adsorption isotherm. Numerical values for the constants a and b can easily be obtained graphically. The K^+ isotherms may then be plotted. The experimental data fall reasonably close to the theoretical isotherms. Three different K^+ isotherms for 3 different Na_e^+ levels were established for: $Na_e^+ = 48$; 120; 168 $\mu\text{Eq}/\text{ml}$. All values for a were smaller than 1. They decreased with increasing Na_e^+ . Values for b were between 2 and 3 and increased with increasing Na_e^+ . The dependence of the constants a and b , in the K^+ -isotherms, upon Na_e^+ may be interpreted as an enhancing effect of Na_e on the adsorption of K_i^+ . All experiments were carried out on isolated pieces of skin which were equilibrated for 8 hours at 25° C. in saline solutions containing varying amounts of NaCl and KCl. The pH of the solutions was kept at about 7.4.

15. INHIBITION OF *in vitro* HEME SYNTHESIS FROM N^{15} -GLYCINE BY 2,5-DIMETHYLBENZIMIDAZOLE, 5,6-DIAMETHYLBENZIMIDAZOLE AND RELATED COMPOUNDS.

Lynn D. Abbott, Jr. and Mary J. Dodson; *Medical College of Virginia.*

Chicken erythrocytes provide a biological test system which continues to make hemoglobin when incubated outside the body. The synthesis can be detected and measured by using N^{15} -glycine from which heavy nitrogen is incorporated into the protoporphyrin of hemoglobin which can be isolated as N^{15} -labeled hemin after incubation.

5,6-Dimethylbenzimidazole is a part of the vitamin B_{12} molecule. The benzimidazoles are also structurally related to the purines. Using chicken erythrocytes as described [see also Va. J. Science, 3, 346 (1952)] we have studied the effect of various alkyl-substituted benzimidazoles on heme synthesis.

2,5-Dimethylbenzimidazole, 5,6-dimethylbenzimidazole and 2-ethyl-5-methylbenzimidazole prevented incorporation of N^{15} from N^{15} -glycine into heme by chicken erythrocytes during *in vitro* incubation. Benzimidazole and 2-methylbenzimidazole had slight, but not comparable, inhibitory action. 5-Methylbenzimidazole had an inhibitory effect intermediate between that of benzimidazole and 2,5-dimethylbenzimidazole. 2-Ethyl-5-methylbenzimidazole was the most potent of all. These are precisely in the same relative order as was found recently by Tamm, et al. for influenza virus inhibition.

The striking coincidence of the relative inhibitory activities of the substituted benzimidazoles for two widely different systems, *in vitro* hemolysis that some very fundamental mechanism underlying both processes is globin synthesis by avian erythrocytes and virus duplication, indicates to us that some very fundamental mechanism underlying both processes is involved. This might be the result of selective inhibition of a basic step in biosynthetic mechanisms in which nucleic acid (or nucleoprotein) plays some very important role.

16. *In Vitro* MEASUREMENT OF POTASSIUM TURNOVER IN RAT SKELETAL MUSCLE.

D. R. H. Gourley; *University of Virginia Medical School.*

As part of an *in vitro* study of the metabolism of the intact extensor digitorum longus muscle of the rat (*Virginia Journ. Science*, 4 : 269 : 1953) the uptake and turnover of potassium by this tissue has been investigated. When incubated in glucose-Ringer solution at 30° C. and equilibrated with oxygen, the extensor muscle maintained 95% or more of its initial potassium content over a 4-hour period. Under these conditions, therefore, the quantities of potassium ions moving into, and out of, the tissue per unit time are approximately equal. Using radioactive potassium, it was found that the turnover rate of potassium ions was $1.36 \pm 0.15\%$ of the tissue potassium per min. The turnover rate showed no great variation over a period of three hours, and there was no significant difference in the potassium turnover rate of opposite muscles from the same animal. Control conditions are therefore established for investigating the effect of hormones on potassium metabolism in skeletal muscle.

17. A SIMPLIFIED METHOD FOR THE DETERMINATION OF AZO DYE IN TISSUE.

J. D. Spain and C. C. Clayton; *Medical College of Virginia.*

One of the criteria of carcinogenic potency of azo dyes is the extent of protein binding of these dyes or their metabolites. Available methods for determination of protein bound dyes are too time-consuming for routine analysis. A method is described for total tissue azo dye which employs alkaline digestion, acidification, filtration and colorimetric measurement of the dye. A blank on the same sample is determined after reduction with stannous chloride. The difference in the two readings is a measure of the units of dye in the sample. The results obtained by

this method for total azo dye parallel those obtained by others for bound azo dye with respect to effect of dietary riboflavin and time of feeding of the dye. Modifications of the method can be used for determination of azo dyes in feces, urine, and diets.

18. INFLUENCE OF CORTISONE ON THE MORTALITY OF X-IRRADIATED ADRENALECTOMIZED MICE.

George A. Stantisteban; *Medical College of Virginia*; J. Z. Bowers and Thomas F. Dougherty; *Departments of Radiobiology and Anatomy, University of Utah*.

The differences in mortality between X-irradiated adrenalectomized non hormone-treated CBA mice and those given daily intraperitoneal injections of graded doses of cortisone (.005, .05, .5, 1 mg/day) were compared by making standard statistical tests on final mortality, and on slopes of the cumulative mortality curves as fitted by the method of least squares.

The final and cumulative mortality of mice adrenalectomized after receiving 650r total body X-irradiation was significantly greater than that of the intact irradiated and adrenalectomized non-irradiated controls. Cortisone replacement therapy failed to fully restore the radio-resistance of adrenalectomized animals. However, statistical analysis of the fitted curves disclosed that the hormone progressively decreased the slopes, increased the mean survival time and delayed the death times (any per cent level) and day of mean death frequency as the dosage was increased. These relationships were statistically significant.

Comparisons of the slopes of the mortality curves suggest that the increased mortality in the experimental animals was associated primarily with an adrenal cortical insufficiency. The presence of the adrenal cortical secretions thus seems to be essential for the resistance to X-irradiation injury. Cortisone, however, may partially restore radio-resistance in the event of an adrenal cortical insufficiency associated with X-irradiation.

19. BOVINE LEPTOSPIRAL MENINGITIS AND UVEITIS.

Warren G. Hoag and Wilson B. Bell; *Virginia Agricultural Experiment Station, Blacksburg*.

Herein reported are two cases in cattle involving unusual syndroma due to *Leptospira pomona* infection. Meningitic symptoms reported in a two-year-old steer are conjunctivitis, profuse salivation, stiffness of foreparts, tenseness of facial muscles and ears, and high temperature. Tentative clinical diagnosis of leptospirosis was confirmed serologically. Recovery was spontaneous and uneventful. Subsequent post mortem examination revealed some evidence of chronic interstitial nephritis and conjunctival petechial hemorrhages. No recovery of the organism was made. Unilateral uveitis is an experimental six-week-old calf occurred seven days after intra-muscular inoculation of a prepaartion containing living *Leptospira pomona* and three days after the first spiking of fever occurred.

Intraocular puncture and immediate culture of the anterior chamber fluid resulted in recovery of organisms which proved to be identical to

the leptospiral serotype inoculated intramuscularly. *Leptospira pomona* was also isolated from the bloodstream on the sixth day after exposure as part of a calf passage experiment. Recovery was spontaneous and uneventful.

MINUTES OF THE SECTION OF PSYCHOLOGY [10]

STANLEY B. WILLIAMS, *Chairman*

HANNAH S. DAVIS, *Secretary-Treasurer*

REUBEN S. HORLICK, *Executive Committeeman*

RICHARD H. HENNEMAN, *Section Editor*

FRIDAY, MAY 7, 1954—9:00 A.M.—PEABODY HALL

CLINICAL SECTION, ROOM 1, PEABODY HALL

1. AN ALTERNATE FORM OF THE SHIPLEY-HARTFORD ABSTRACTION SCALE.

Reuben S. Horlick; *Walter Reed Army Hospital, Washington, D.C.*

This study concerns itself with the development of an alternate form to the Shipley-Hartford Scale, which has been found useful in obtaining a quick estimate of present intellectual functioning and for detecting impairment in mental efficiency.

The original and alternate forms of the Shipley-Hartford Scale were administered to two groups of army male recruits. Group A (112 men) was given the alternate form first and the original immediately afterward. To Group B, the tests were administered in reverse order.

The coefficient of correlation between Form 1 and Form 2 for Group A is .79 and for Group B, .80. The main differences from test to test are significant at the .01 level for Group A, and at the point .02 level of confidence for Group B. Approximately the same degree of variability is present in the two forms and the order of presentation does not alter significantly the test scores.

An alternate form to the Shipley-Hartford Abstraction Scale has been developed, and preliminary evaluation with two groups of army recruits indicates a high degree of reliability. It is, therefore, believed that the alternate form may be safely substituted for the original, when necessary.

2. ABSTRACT AND CONCRETE THINKING IN SCHIZOPHRENIA: A VOCABULARY STUDY.

A. W. Jeffreys, Jr.; *Richmond Professional Institute.*

The present study is one of a series of proposed investigations into the language and thought of schizophrenics. It limits itself to a specific testable hypothesis of Goldstein, who states that in the language of the schizophrenic "there is an absence of generic words which signify categories or classes. Or when they do use such words, analysis shows that . . . they do not conform to generalizations."

To test this hypothesis, the first 37 words of Wechsler's vocabulary subtest (Form II) were administered to 20 schizophrenics and 20 psychiatric attendants, the two groups being matched in age, intelligence, and education. Each definition was classified according to Green's method into one of five categories.

The tests were scored and tabulations made to arrive at the total number of responses each of the two groups had in each of the five categories. Primary interest was in the performance of the two groups in the number of responses in category 1 (for which they had to assume the more abstract attitude, producing definitions signifying categories or classes). It was found that the schizophrenic group produced more category 1 responses than did the comparison group. This difference was significant in the .05 level of confidence, and Goldstein's hypothesis was rejected.

3. AN INVESTIGATION OF REVISED BETA SCORES (LINDNER-GURVITZ SCALE) AMONG NEGRO ADOLESCENTS.

Walter A. Woods, Jack H. Boger, and Georgiana L. Holman;
Richmond Professional Institute and Richmond Public Schools.

Testing experience had revealed that Negro adolescents, delinquent and not delinquent, typically scored lower on subtest four of the Lindner-Gurvitz Scale of the Revised Beta, than on any other sub-test. Since the Lindner-Gurvitz Scale was designed to provide sub-test equality, it appeared desirable to determine whether a real difference existed among Negro adolescents in performance on the Beta sub-tests.

Test results of 39 female and 32 male Negro juvenile delinquents and 35 female and 15 male Negro adolescents were analyzed for differences between (1) sexes, (2) sub-test means, and (3) total test means. All differences were tested at the .05 level by F test and critical differences. Sub-test and total test scale score intercorrelations were determined.

It was found that (1) non-delinquents score significantly higher than delinquents, (2) sex differences are not significant, (3) subtest four mean score is significantly lower than any other sub-test score, (4) sub-test four correlates .66 with total score, and when compared to other sub-test-total score correlations, is highly related.

It is concluded that either the Lindner-Gurvitz Scaled scores do not contribute equally to total score or that some cultural factor causes adolescent Negroes to perform particularly badly on sub-test Four.

4. HOUSE-TREE-PERSON RESEARCH ON CHILDREN.

A. THEORY AND METHOD IN H-T-P RESEARCH.

Vytautas J. Bieliauskas; *Richmond Professional Institute.*

In addition to psychological techniques devised to test different personality characteristics through evaluation of verbal expression, drawing has attracted the attention of the clinicians for some time. For about 15 years, drawing has been used in the United States as a projective techni-

que. Buck's H-T-P manuscript was one of the first publications of this kind, representing a psychological test for the appraisal of adults.

In the fall of 1952, RPI's Graduate School of Clinical and Applied Psychology initiated a long range H-T-P research project which has been discussed and encouraged both by Buck and by the members of the H-T-P panel at the 1953 APA meetings in Cleveland, Ohio. This project includes three main steps: (1) a developmental study of children's drawings and adaptation of the scoring system to children, (2) qualitative studies of children's H-T-P, and the integration of these qualitative findings with current personality theories, and (3) cross-validation of the adult's H-T-P following the findings on children.

The three studies presented on this panel hereafter were done on random samples drawn from 10,576 children's drawings of H-T-P, obtained from Illinois public schools, and they represent the developmental data on the drawing of the House, the Tree, and the Person. The fourth paper endeavors in theoretical considerations concerning perception and representational drawing, and a comparison of representational drawing with children's drawings.

B. DEVELOPMENTAL ASPECTS IN DRAWING OF THE HOUSE.

Walter A. Woods and Lawrence C. Repucci; *Richmond Professional Institute.*

A study of 374 H-T-P house drawings, sub-divided by school grade — 1st through 9th grade,—was conducted to ascertain developmental trends.

Drawings were studied and classified according to the following criteria:

- I. Dimensions, sub-divided into one and two point perspective, implied perspective, double perspective, flat frontal view, interposed planes, parallel planes, and relative size;
- II. Picture structure, which included proportion, composition, basic geometrical structure and page placement; and
- III. Details — essential and non-essential. These classifications differ somewhat from those of Buck.

It was found that (1) three dimensional representation is clearly developmental, as is the style of composition and the structuring of the picture. The use of details has less clear developmental significance. The use of some details decreases while the use of other details increases with increase in age.

Cultural determinants of developmental differences have not been investigated.

C. THE DEVELOPMENT OF FORM CONCEPTS IN THE DRAWING OF A TREE BY CHILDREN: KINDERGARTEN THROUGH THE NINTH GRADE.

Frank X. Duffy (read by John J. Digiammo); *Richmond Professional Institute and Mt. Pleasant Mental Health Institute.*

A sample of 500 H-T-P tree drawings were examined. The various aspects and form qualities of the drawings were tallied under six main

headings as follows: (a) Development of the use of ground line and paper basing, (b) Development of the use of space, (c) Development of the tree form, (d) Development of two or more dimensions, (e) Development of light and shade and the modeling of a surface, and (f) Development of the use of details. It was found that males and females did not differ significantly in their representations of a tree by drawing. There was a general tendency at all grade levels to have a preference for curved rather than straight lines.

The progression appears to be from the simple geometric forms—circles and squares—found in the Kindergarten to the more detailed complex representations—interposition, light and shade and modeling—of the ninth grade. The present study permits the conclusion that there are several stages in the development of drawing so that ability to draw improves with experience and training.

D. DEVELOPMENTAL TRENDS IN CHILDREN'S H-T-P DRAWINGS OF A PERSON.

Vytautas J. Bieliauskas and Leonard W. Pennington, Jr.; *Richmond Professional Institute.*

A study of 630 H-T-P person drawings, representing chronological ages 4½ to 15, was made to determine developmental trends.

The following aspects of the drawings were studied: (1) *Composition*, (2) *Proportions*, (3) *Dimensions*, and (4) *Details*. Composition includes the placement of the figure on the page, position of the limbs, detail forms, etc. Grouped under proportions are the size of the figure and several interpart ratios. Dimensions involve one dimensional and two dimensional representations, as well as three dimensions, or depth representation. Details refer to the presence or absence of a part of the figure or its clothing.

The sample was divided into one-half year groups and the drawings were evaluated in terms of 97 categories. Significant age differences were found in many respects of Composition, Proportion, and Dimensions, as well as Details. Statistical findings warranted the hypothesis that many aspects of person drawings clearly show changes occurring with age and that therefore, they may be termed as developmental changes. The nature of the development of person drawing is, in general, in the direction of greater complexity and conformity to the visual appearance of human figure.

Sex differences were found in several aspects of the person drawings; they were particularly noticeable in mode of presentation.

No qualitative conclusions were drawn on the basis of this study.

5. THE INFLUENCE OF EMOTIONAL DEPRIVATIONS ON THE TEST SCORES OF INFANTS.

Catherine T. Giblette; *Memorial Guidance Clinic, Richmond.*

The study presents twenty-eight infants who were psychologically examined before and after placement or treatment. Many of them rated

low and even mentally defective during their period of emotional neglect. Then after placement with foster parents which supplied the babies with love, companionship, and understanding, most of the infants' mental classifications showed remarkable gain. The several infants whose mental quotients failed to rise were in homes that were destructive to their development, or they continued to live in an institution.

It is concluded that:

1. Infants are unable to develop when they are deprived of emotional satisfactions.
 2. The Clinical Psychologist should be most careful and cautious in interpreting an infant's test results. He should acquaint himself thoroughly with the emotional background of the baby.
 3. In placing infants the foster parents should be selected most carefully as to their feeling for the babies and capacity to guide their mental and emotional development.
6. A PRELIMINARY REPORT OF SOME RORSCHACH CHARACTERISTICS OF ALCOHOLIC PATIENTS.

John Mendenhall; *Lynchburg State Colony*.

The standard Rorschach blots were administered to 138 male (voluntary alcoholic) patients. Significant findings were high animal percentage, presence of black color response, and a W to M ratio of 3 to 1 or more. Qualitatively, the records suggested sudden emotional outbursts and a neurotic personality structure. Low insight and active conflict were present, with a generalized sexual insecurity. Projection was a common defense mechanism.

This group was compared with a group of 124 alcoholic patients to whom the Behn blots had been administered. No significant difference was found in the two sets of protocols except that CF responses tended to predominate on the Rorschach while FC responses tended to predominate on the Behn.

A group of 24 dull-average intellectual patients and a second group of 30 patients of high-average intelligence were separated from the Rorschach group. The general profile obtained earlier on the Rorschach tended to hold true in each group, with the exception that the number of shading responses tended to drop in the dull-average records. No correlation was seen between intelligence and the W to M ratio or animal percentage.

7. IDENTIFICATION AND GUIDANCE OF GIFTED CHILDREN IN THE ELEMENTARY SCHOOLS.

Antonia Bell Morgan; *Aptitude Associates Incorporated, Merrifield*.

The history of the problem is briefly reviewed, with particular reference to ancient Greece, 19th century England, and modern psychological and educational trends.

A study of the figures of the winners in the Westinghouse Annual Science Talent Search reveals an uneven distribution suggesting that meas-

ures to identify and foster talent in the schools are likewise unevenly distributed.

For most effective guidance, gifted children should be identified in the elementary schools. Provisions for gifted children in the elementary schools take the form of (a) homogeneous grouping, (b) enrichment, or (c) acceleration. The assets and drawbacks of each of these methods are discussed with special reference to the programs of Hunter College and of the State of Oregon.

The following conclusions are reached:

- (a) In many school systems the needs of gifted children are not being adequately met.
- (b) There should be special provisions for such children in the elementary schools.
- (c) In the elementary schools either homogeneous grouping or acceleration is usually preferable to enrichment.
- (d) Each gifted child should be given a comprehensive psychological examination and periodic guidance on the basis of the findings.
- (e) A program for the identification and guidance of gifted children in the elementary schools must be flexible, simple, and relatively inexpensive.

A tentative program is proposed which would meet the requirements outlined in (e) above.

EXPERIMENTAL SECTION, ROOM 15, PEABODY HALL

1. VISUAL DIFFERENTIATION AFTER NON-REINFORCED TRAINING IN DIFFERENTIATED ALLEYWAYS OF A T-MAZE.

Melvin Freitag; *University of Virginia.*

Rats were given unrewarded trials in brightness-differentiated alleys and goal-boxes of a T-maze. They were then placed in a different brightness discrimination situation where one of the cue complexes (brightness) was associated with food. After the discrimination had been established the animals were placed in a gray T-maze having colored goal-boxes. The rats had not benefited from their previous unrewarded position training as demonstrated by the fact that they did not respond appropriately. They did not learn the location of food any faster than the control group that received their training in a gray maze with colored goal-boxes.

2. AN EXPERIMENTAL EVALUATION OF THE GENERAL DRIVE CONCEPT

James G. Holland; *University of Virginia.*

An experiment in progress was reported which was designed to test the general drive hypothesis without using drives that are intrinsically confounded as are hunger and thirst. Rats were trained in a Skinner box to avoid shock by pressing a lever. When the avoidance habit was well established the animals were deprived for either 0, 24, 48, or 72 hours.

They were then returned to the Skinner box and tested for the different rates of responding that should result from the different drive levels. Of the eleven animals which have completed the experiment thus far, all but one responded at a lower rate during the test session than during the last acquisition session. These incomplete data would suggest that there will probably be no significant group differences. If this is verified in further planned research, the general drive hypothesis will have to be either abandoned or modified.

3. CONFLICT-PRODUCED CHANGES IN THE BEHAVIOR PATTERNS OF RATS.

William A. Lee; *University of Virginia.*

Six water-deprived rats were taught to perform a brightness discrimination in a snug restraining cage. Correct responses were rewarded with water, and incorrect responses were punished with electric shock. When the discrimination was well established, three of the animals were presented with a conflict situation by reducing the difference in brightness which was to be discriminated. The conflict was continued during six daily training sessions while the three control animals continued to perform the original discrimination. No differences were found between the two groups during the six day period with respect to changes in activity in the home cages, food consumption, or body weight. The control groups demonstrated better retention of a previously learned bar-pressing habit. The control group also recovered more rapidly from an "emotional state" produced by a bright flash of light.

4. CUTANEOUS COMMUNICATION SYSTEMS UTILIZING MECHANICAL VIBRATION.

Paul Spector; *University of Virginia.*

Past failures to transmit speech directly to the skin by means of vibration make it appear that information must be encoded to be transmitted tactually.

Intensity, temporality, and spatial extent of vibratory stimulus were explored in an attempt to determine the number of cues in each that can be utilized in encoding information.

Six experiments were conducted. Two studies investigating the difference limens for intensity and duration preceded two further studies in which equal levels of intensity and of duration which could be identified with an accuracy of 100 percent were found. All subjects could identify three levels of j.n.d.'s in each dimension consistently.

In a fifth study it was found that all subjects could identify four loci of vibration correctly although none could identify more than six levels.

In a final experiment a determination was made of the ability of subjects to identify several aspects of the vibratory stimulus.

Thirty-six stimuli were delivered and of the four subjects who participated, one made no errors, and each of the others made one error.

5. VISUAL CONTRIBUTION TO SPEECH INTELLIGIBILITY IN NOISE.

William H. Sumby; *University of Virginia.*

Oral speech intelligibility tests were conducted with and without supplementary visual observation of the speaker's facial and lip movements. The difference between these two conditions was examined as a function of the speech-to-noise ratio and the size of the vocabulary under test. The visual contribution to oral speech intelligibility (relative to its possible contribution) is, to a first approximation, independent of the speech-to-noise ratio under test. However, since there is a much greater opportunity for the visual contribution at low speech-to-noise ratios, its absolute contribution can be exploited more profitably under these conditions.

6. DURATION OF SUCCESS-BACKGROUND AND THE EFFECT OF FAILURE UPON PERFORMANCE.

James A. Bayton; *Howard University.*

The present experiment was designed to yield data on two critical problems: 1) is introduction into a failure situation after a series of successes accompanied by erratic performance? and 2) is the level of performance under failure a function of the extent of prior success experiences?

Seventy-five male subjects were used in the experiment. They were randomly divided into three groups. They received varying amounts of prior success before being introduced to failure. The task used was the Minnesota Rate of Manipulation Test.

The results gave evidence that erratic performance resulting from a success-failure situation is perhaps a function of the sex of the experimenter. The results also demonstrated that the level of performance under failure is a function of the extent of prior success. With a limited amount of success prior to failure there is no differential influence on performance. However, with a relatively large amount of prior success there is a differential increase in speed under a failure situation. Accumulation of success background facilitated learning under subsequent failures.

7. THE EFFECT OF VARIABLE AMOUNT OF REINFORCEMENT UPON THE RATE OF RESPONSE.

Kenneth Hageman; *College of William and Mary.*

8. THE EFFECT OF KNOWLEDGE OF RESULTS ON THE ACCURACY OF A PURE GUESSING RESPONSE.

Burton R. Wolin and Althea M. Iliff; *College of William and Mary.*

9. THE EFFECT OF DIFFERING NUTRITIVE REINFORCEMENT UPON LEARNING.

William Wagman; *College of William and Mary.*

The purpose of this experiment was to determine if rats will learn to run to diluted food as well as to regular food. Such an experiment might

help in clarifying the term "reinforcement".

Three groups of animals were tested for reaction latency and running time in a closed runway. Food pellets for the three groups consisted of 100%, 50%, and 20% Purina Chow respectively. Dilution was with non-nutritive fiber and sawdust. All pellets were of the same size. An addition of 1% saccharine was used to mask potentially different tastes. All animals were run once a day every other day during learning and three times a day every other day during extinction.

The results show no differences between groups during acquisition and extinction. It is hypothesized that nutritive value has no reinforcing effects when bulk and taste are held constant.

10. DIFFUSION THEORY AND ITS APPLICATIONS TO SOCIAL RESEARCH.

Henry Winthrop; *Richmond Professional Institute.*

The objectives of diffusion theory, both theoretical and applied, are stated. Various types of diffusion theory are mentioned. The difference between clock-time and remove-time models is discussed. The nature of a two-stage theory of diffusion is described. The basic parameters of diffusion theory are explained. The basic taxonomy of the necessary mathematical models is furnished. A representative diffusion model is given and recent empirical application of diffusion theory touched upon.

BUSINESS MEETING, ROOM 106, PEABODY HALL

The business meeting was opened by the Chairman at 2:00 p.m. A slate of two candidates for each of the three offices was presented by the Chairman of the Nominating Committee. The following officers were elected by ballot: Chairman, Gilbert J. Rich; Secretary-Treasurer, Audrey M. Shuey; Executive Committeeman, Henry A. Imus.

The Section editor announced that the editorial staff of the Journal would like a report of the Section's feeling about whether titles and/or abstracts of articles by the V.A.S. members published during the year should appear in one Journal issue during the year. Sixteen members felt the listing advisable, 10 were against it, and 12 had no feeling about the matter.

The Secretary's and Treasurer's reports were accepted as read.

The Chairman asked the Section if it wished to go on record with a letter to the Governor expressing its opinion on the reappointment of the Commissioner of Mental Hygiene and Hospitals. A motion was made and seconded that the Section write a letter to the Governor (with a copy to Dr. Barrett) requesting the reappointment of the present Commissioner of Mental Hygiene and Hospitals. After discussion, it seemed clear that the majority of the members present were of the opinion that this was not an appropriate question for the Section to take action on, and the motion, therefore, failed.

Just prior to this meeting, the Chairman had received a letter from a member in Richmond expressing the views of several of the members of

the Richmond Psychological Association. The letter indicated that the present Section did not meet all the needs of all the psychologists in Virginia and suggested that the matter be brought up at the business meeting with a view toward either changing the present organization to meet these needs or forming a new psychological association. The Chairman reported that this matter had already been discussed by the Section's Executive Committee and subsequently by the Executive Committee and the delegate of the Richmond group. The Chairman also reported that it had been suggested that the new officers appoint a study committee and meet with them to discuss the whole matter of reorganization and/or separation from the Section. A member then made the following motion: I move that the incoming Executive Committee be instructed to appoint a committee of three to five members, which committee would be representative of the members of this Section, to re-examine and re-evaluate the constitution, functions, and responsibilities of the Psychology Section and to report to the Board its findings and recommendations at the earliest opportunity. This motion was carried.

The meeting adjourned at three o'clock.

SYMPOSIUM, 3:00 P.M.—PEABODY HALL

What Kind of Research Studies do Clinical Psychologists Need?

- Chairman William N. Hinton, Washington and Lee University;
- Dr. Harold M. Hildreth, Veterans' Administration Central Office;
- Dr. Thelma Hunt, George Washington University;
- Dr. Morris Roseman, Veterans' Administration Regional Hospital;
- Dr. Burton R. Wolin, College of William and Mary.

MINUTES OF THE SECTION OF SCIENCE TEACHERS [11]

CAROLINE GAMBRILL, *Chairman*
G. L. THOMASSON, *Chairman-Elect*
MARTHA W. DUKE, *Secretary*
L. W. JARMAN, *Section Editor (1954)*

FRIDAY, MAY 7, 1954—9:30—ROOM 122, COBB CHEMICAL LAB.

1. THE SCIENCE TEACHER'S RESPONSIBILITY IN CIVIL DEFENSE.

Thomas E. Gilmer; *Hampden-Sydney*.

2. ATOMIC ENERGY.

Edward C. Stevenson; *University of Virginia*.

The Gamow-Alpher theory of the origin and explanation of our expanding universe was cited as a gigantic thermonuclear reaction which, interrupted before it had gone to completion, provides us with the rarity and abundance of the elements as we find them today, approximately five billion years later. The binding energies of the isotopes were developed from a consideration of mass measurements, and Einstein's mass-energy equation and the two possibilities of fission or fusion for extracting further energy by rearrangement of nucleons were discussed. The fusion process in thermonuclear reactions at high temperatures provided by a fission A-bomb was examined with regard to the most promising materials to use.

The impossibility of an H-bomb explosion "getting out-of-hand and setting off" the atmosphere or ocean was pointed out.

3. WHAT'S NEW IN CRYSTALS.

Nicolas Cabrera; *University of Virginia*.

Atoms interact with each other by forces which have only recently been understood. Those short-range forces, usually called chemical forces, are of quantum-mechanical nature. Because of those forces atoms join together forming groups of finite dimensions which we call molecules or of infinite dimensions which we call crystals. The entire field of Biology is based on the existence of large molecules about which we know very little. On the contrary, our knowledge of the properties of crystals, developed during the last half-century, is very complete. The understanding of it is based on the hypothesis that the atoms form a perfectly periodical lattice, extending through the entire volume occupied by the crystal. It is only recently, however, that there has been recognized the necessity of introducing the possibility of geometrical imperfections in the lattice in order to explain some of the most important properties of solids, such as

mechanical properties, crystal growth, etc. These geometrical imperfections (dislocations) have been observed recently.

4. WHAT'S NEW IN NUCLEAR PHYSICS.

Frank L. Hereford; *University of Virginia.*

The current status of nuclear physics and the physics of elementary particles was reviewed. These fields of physics are experiencing very great difficulties at the present time due primarily to the experimental discovery of an abundance of different elementary particles. There is a place within the framework of physics for many of these new particles. For example, the bi-meson is thought to be the quantum of the nuclear force field analogous to the photon as the quantum of the electromagnetic field. However, most of the recently discovered particles (K-particles and hyperons) have not as yet found a home within physical theory. The role of the giant accelerators (e.g., the recently completed bevatron) in adding to our knowledge of the properties of these new particles was also indicated.

BUSINESS MEETING

Miss Gambrill appointed Mr. L. W. Jarman, Mr. A. B. Niemeyer and Mr. Harry M. White to serve on the nominating committee. The following slate was presented:

Chairman-Elect--Franklin D. Kizer

Secretary--Martha W. Duke

Section-Editor--Caroline Gambrill

As there were no nominations from the floor, these officers were declared elected.

**MINUTES OF
THE SECTION OF STATISTICS [12]**

W. S. Connor, *Chairman*

M. C. K. TWEEDIE, *Vice-Chairman*

C. Y. KRAMER, *Secretary*

LIONEL WEISS, *Editor (1957)*

FRIDAY, MAY 7, 1954—9:00 A.M.—ROOM 243, CABELL HALL

1. THREE-DECISION TESTS OF A DIFFERENCE BETWEEN TWO MEANS.¹

D. B. Duncan; *Virginia Polytechnic Institute.*

A distinction is first made between a *two-decision* test of $H_0: \delta = 0$ in which the decisions are D_0 : accept H_0 and D_1 : accept $H_1: \delta \neq 0$ and a *three-decision* test of $H_0: \delta = 0$ in which the decisions are D_- : accept $H_-: \delta < 0$, D_0 : do not reject H_0 , and D_+ : accept $H_+: \delta > 0$; where δ is the expected difference between two sample means. It is shown that the operating characteristic curve of a two-decision test cannot be used satisfactorily to represent the properties of a three-decision test, as is sometimes attempted. An α -level three-decision test may be usefully regarded as a combination of two two-decision tests; one, an α_1 -level test of $\delta \leq 0$ against $\delta > 0$, the other, an α_2 -level test of $\delta \geq 0$ against $\delta < 0$; where $\alpha = \alpha_1 + \alpha_2$. The operating characteristics of the three-decision test are given by the operating characteristics curves of these two tests. Attention is also drawn to another type of two-decision test having decisions D_- and D_+ . This may be regarded as a special case of the three-decision test in which D_0 is excluded by putting $\alpha = 100\%$.

2. ON A NEW METHOD OF ANALYZING EXTREME-VALUE DATA.²

Julius Lieblein; *National Bureau of Standards.*

This paper presents an approach to estimation of the parameters of the extreme-value distribution

$$F(x) = \text{Prob } (X \leq x) = \exp (e^{-(x-u)/\beta})$$
 by means of linear functions of order statistics, $T = \sum_{i=1}^n w_i x_i$, where $x_1 \leq x_2 \leq \dots \leq x_n$ are

the order statistics in a random sample of size n from $F(x)$. Two desirable properties of such estimators are unbiasedness and minimum variance (from among such estimators). These two properties uniquely determine

¹ Sponsored by Office of Ordnance Research, U. S. Army.

² Sponsored by the National Advisory Committee for Aeronautics.

the n weights w_i from the means, variances and covariances of the x_i . The means have previously been tabulated. Explicit formulas which have been found permit simple numerical computation of the variances and covariances from tabulated functions alone. Estimators based on these are constructed for samples of $n \leq 6$, larger samples being handled by breaking up into subgroups of six or less. This method appears to offer the following advantages over existing methods based on mean and standard deviation of an entire sample: (1) the estimators are unbiased; (2) in many cases the estimators have greater efficiency; (3) breaking sample into subgroups allows possibility of checking whether data are random and come from assumed type of distribution.

3. SOME DUPLEX METHODS OF USING DESK CALCULATORS IN STATISTICS.

M. C. K. Tweedie; *Virginia Polytechnic Institute*.

Some methods of doing two separate calculations simultaneously on a desk-type digital calculator are very efficient in some problems, but are not known very widely. The method of finding $S(x)$ and $S(x^2)$, or $S(fx)$ and $S(fx^2)$ for grouped data, by entering 1 and x , or x and x^2 , on opposite ends of the multiplier keyboard, is perhaps fairly well known. This paper demonstrates how, following this stage, the sum of squares can be corrected to $S(x - \bar{x})^2$ simultaneously with the calculation of the mean (\bar{x}), by setting up n under $S(x)$ and $S(x)$ under $S(x^2)$, and carrying out the operation of dividing n into $S(x)$. The corrected sum of squares is produced in a position where it can be divided by n or by $n-1$ to give the variance. Details, including limitations, of several variants of this idea are given. The ease of usage of at least one of these variants (depending on the type of machine) can greatly facilitate the calculation of variances from small samples, such as arise in some quality control techniques and analyses of variance. The same broad idea can also be used to get the corrected sum of products $S(x - \bar{x})(y - \bar{y})$ from the raw sums $S(xy)$, $S(x)$, $S(y)$, simultaneously with the computation of \bar{x} (or \bar{y}).

4. ON A PROBLEM IN FITTING A STRAIGHT LINE.

W. S. Connor; *National Bureau of Standards*.

Phenomena sometimes occur for which it is known that certain observable variables x and y have a functional relationship of the form

$$y = \alpha + \beta x,$$

but the constants α and β are unknown.

Suppose that it is desired to estimate α and β by estimating two points on the line, (x_1, y_1) and (x_2, y_2) , ($x_1 < x_2$). Further suppose that x_i ($i = 1, 2$) is known without error but that y_i can be observed only through the random variable Y_i which has a continuous distribution function with a unique median, y_i .

Let the observations y_{i1}, \dots, y_{iN_i} on Y_i be independent. Then a simple non-parametric simultaneous confidence interval for all the y 's may

be constructed in the following way. Arrange y_{i1}, \dots, y_{iN_i} in increasing order and select the k_i th and $(N_i - k_i + 1)$ th order statistics ($k_i \leq (N_i - 1)/2$), which may be denoted by $y_{i(k_i)}$ and $y_{i(N_i - k_i + 1)}$, respectively. Consider the points $Z_{1L} = (x_1, y_{1(k_1)})$, $Z_{1U} = (x_1, y_{1(N_i - k_i + 1)})$, $Z_{2L} = (x_2, y_{2(k_2)})$, and $Z_{2U} = (x_2, y_{2(N_2 - k_2 + 1)})$. Then the upper simultaneous confidence limit consists of the following three straight line segments: (1) the line determined by Z_{1U} and Z_{2L} for $-\infty < x \leq x_1$, (2) the line determined by Z_{1U} and Z_{2U} for $x_1 < x \leq x_2$, and (3) the line determined by Z_{1L} and Z_{2U} for $x_2 < x < \infty$. The lower limit is determined analogously.

Let

$$P_i = \left(\frac{1}{2} \right)^{\sum_{j=k_i}^{N_i - k_i + 1} \binom{N_i}{j}}, \quad (i = 1, 2).$$

$$j = k_i$$

Then the confidence coefficient associated with the interval is $P_1 P_2$.

5. SOME TOPICS IN VARIANCE COMPONENT ANALYSIS.

W. A. Thompson, Jr.; *Virginia Polytechnic Institute*.

Wald's confidence interval ("A Note on Regression Analysis", Annals of Math. Stat., p. 586, Dec. 1947) is specialized to the case of incomplete block designs with random block effects. A theorem concerning the multiplicity of the characteristic roots of the variance-covariance matrix of the adjusted yields is discussed and applied to Wald's confidence interval. A practical example is discussed.

This work was done under contracts with the Air Force and the Quartermaster Corps.

6. A STATISTICAL ANALYSIS OF THE INSONATION EFFECTS OF *Escherichia coli*.

Patricia Ripley, M. C. K. Tweedie and Dudley Thompson; *Virginia Polytechnic Institute*.

The lethal effects ultrasonics have on *E. coli* under various times and intensities of insonation were studied in this experiment, using statistical methods.

Five hour cultures were treated by insonation at 400 kilocycles for either 1, 3, 9, or 27 minutes. The intensity levels were 15 milliamperes at 100 volts, 30 milliamperes at 200 volts, 70 milliamperes at 400 volts, 130 amperes at 800 volts, and 270 milliamperes at 1600 volts. Two controls were prepared for each treated sample. After insonation all three samples were cultured in petri dishes and their colonies counted in 24 hours.

A 100 per cent killing effect was observed at 270 milliamperes and 1600 volts, and nine minutes. Large variation between and within controls prevented direct interpretation of results. The scatter between control's was considerably greater than for a Poisson distribution. Methods for analyzing the data to measure the incomplete killing effect at lighter intensities and shorter time exposures are currently in progress. Exponential laws of decrease in colony count against duration of insonation fit approximately.

7. A MINIMIZATION PROBLEM.

Joseph B. Jordan; *Headquarters, USAF.*

A square matrix can be rearranged by permuting the rows and columns in an identical manner. It is desired to find the rearrangement of this type which will give the minimum sum of the elements above the main diagonal.

The method described is one which has been used on the Univac at the Office of the Comptroller, Hq. USAF. The original matrix is expressed as the sum of a symmetric and a skew-symmetric matrix. Since the symmetric matrix has an invariant sum above the main diagonal under the kind of rearrangements allowed, it can be ignored. A series of permutations of rows and corresponding columns is found which will minimize the sum for the skew-symmetric matrix. The series of permutations is reduced to one equivalent permutation, which is applied to the original matrix to minimize its sum above the main diagonal. The advantage gained by working with the skew-symmetric matrix is that since $a_{ij} = -a_{ji}$, it is necessary to store only the elements above the main diagonal. This more than doubles the size of the matrix which can be readily handled.

The solution found is not necessarily the true minimum. Known methods which would assure finding the true minimum require a prohibitive amount of computation. Empirical tests have shown that the method described generally produces a substantial reduction in the sum above the main diagonal.

8. THE OPTIMUM TRANSPORTATION PROBLEM.

Melchior J. DiCarlo-Cottone; *Headquarters, USAF.*

Let X_{ij} be the amount of a homogeneous product which is to be shipped from origin $i(i=1, 2, \dots, m)$ to destination $j(j=1, 2, \dots, n)$. Let the amount to be shipped from each origin be a_i and the amount to be received by each destination be b_j . Further, let it be stipulated that the total supply equals the total demand. A table c_{ij} is given, which is the cost of shipping a unit amount from the i^{th} origin to the j^{th} destination. The problem is to minimize the total cost.

Stated algebraically, let

$$(1) \quad \sum_{j=1}^n X_{ij} = a_i \quad i = 1, 2, \dots, m$$

$$(2) \sum_{i=1}^m X_{ij} = b_i \quad j = 1, 2, \dots, n$$

$$(3) \sum_{i=1}^m a_i = \sum_{j=1}^n b_j$$

$$(4) X_{ij} \geq 0$$

then choosing the correct X_{ij} in (1), (2) and (4) we have

$$(5) \sum_{j=1}^n \sum_{i=1}^m c_{ij} X_{ij} = \text{Minimum}$$

An illustrative example using a 3×5 c_{ij} matrix, a 3 element column vector and a 5 element row vector is presented.

A simplified flow diagram, utilizing the above principles, shows the approach used in adapting such a problem to a large-scale digital computer.

9. AUTOMATIC PROGRAMMING.

Natalie Coplan; *Headquarters, USAF.*

A large scale digital computer solves problems as directed by sets of instructions called programs. Ordinarily, these instructions are the result of much human effort. Manual preparation is a long, arduous job. Techniques are being developed which enable the computer to assume much of this labor. These techniques and their role in problem solution are explored.

As an example of the compiler techniques, the steps involved in the tabulation of the function

$$x = \frac{b(a - c \cos \alpha)}{\sqrt{z^2 + a^2 + c^2 - 2 ac \cos \alpha}}$$

are discussed.

10. THE EFFECTS OF BIMODALITY AND OF SKEWNESS IN A POPULATION ON THE DISTRIBUTION OF "T".

J. C. Layman and R. A. Bradley; *Virginia Polytechnic Institute.*

The small sample test, known as the "t" test, for hypotheses on the mean of a normal population developed by "Student" and modified and extended by R. A. Fisher is still of outstanding importance in Statistics. For the strict validity of the test it is required that the sample be of independent observations from a single Gaussian distribution. In practice these conditions are never more than approximately met.

R. A. Bradley, in 1952, presented a general mathematical approach to

obtaining approximations to the distribution of "t" for specified non-normal populations. Examples developed were restricted to symmetrically distributed populations.

In the present paper, the effects of sampling from a mixed population with density function $f(x) = a_1 \phi_1 + a_2 \phi_2$, where $a_1 + a_2 = 1$; $a_1, a_2 \geq 0$ and ϕ_1, ϕ_2 are normal or Gaussian densities with possibly different means and variances were partially investigated. This density is of interest since, with changes in a_1, a_2 and the means or variances of the ϕ 's, it may be used to represent populations which are bimodal or which have varying degrees of skewness.

Two special forms of the general density above were selected and studied in some detail for samples of size two. The results obtained from the study of the two density functions considered indicate that the probabilities that "t" exceed preassigned values t_o differ only slightly from the corresponding probabilities for the normal density. Thus, these results substantiate the opinion that the effects of moderate departures from normality may not be serious in the analysis of variance of sample means.

11. ANALYSIS F PASTURE DATA IN 3 X 3 LATIN SQUARES. WITH ROWS AND SINGLE OBSERVATIONS MISSING.

N. R. Thompson and C. Y. Kramer; *Virginia Polytechnic Institute*.

Three pasture mixtures were grown in four replicates, and grazed rotationally by three groups of dairy cows. The grazing plan followed was based on 3 x 3 Latin squares. Data on milk yields and body weights were taken. Yields of total digestible nutrients and dry matter per acre were estimated.

The rows of each Latin square represented successive grazings of a given replicate. In two seasons (1950, 1951) one square and one or two rows were completed. In one season (1952) two squares were completed, but a few observations were missing.

Analysis of the data with rows missing was done conveniently by the fitting of constants. Only two equations in two unknowns were needed to obtain each constant for "Mixtures" and "Groups". The analysis of variance then proceeded in the usual manner. Procedures using formulas for missing values were applied to the 1952 data.

With rows missing, "Mixture" means were adjusted for "Group" effects in the pooled analysis of all replicates and to test individual differences. With individual observations missing, actual means were used with appropriate standard errors.

12. SOME ASPECTS OF STATISTICS IN CANADA.

G. L. Edgett; *Virginia Polytechnic Institute and Queen's University*.

The scope of statistics in Canadian universities at the graduate and undergraduate level. The role played by statistics in industry and in government.

13. A 2 x 2 FACTORIAL WITH PAIRED COMPARISONS.

Robert M. Abelson and Ralph Allan Bradley; *Virginia Polytechnic Institute.*

The parameters previously specified for a method of paired comparisons are redefined in such a way as to permit the use of treatments in factorial array. The algebraic procedure is shown in general, but the normal equations resulting from the use of maximum likelihood are non-linear and difficult to solve. Easy solution of the normal equations seems to be limited to the 2 x 2 factorial and an explicit solution is given for that case.

The method of paired comparisons presented for 2 x 2 factorial treatments permits most of the comparisons available through usual analysis of variance. It is possible to test for the presence of both main effects and their interaction.

A numerical example is included.

14. TESTING ONE SIMPLE HYPOTHESIS AGAINST ANOTHER.

Lionel Weiss; *University of Virginia.*

For the problem of testing one simple hypothesis against another, of all tests whose probabilities of incorrectly accepting the first hypothesis and of incorrectly accepting the second hypothesis are bounded from above by given bounds, the familiar Wald sequential probability ratio test gives the smallest expectation of sample size under either hypothesis. In this paper, a "generalized sequential probability ratio test" is introduced which differs from the Wald test only in that the same limits (A, B in the usual notation) are not necessarily used at each stage of the sampling, but at the i^{th} stage A_i and B_i are used, where these numbers are predetermined constants. It is shown that for any given test T, there is a generalized sequential probability ratio test G whose probabilities of incorrectly accepting either hypothesis are no larger than the corresponding probabilities for T, and such that the cumulative distribution function of the number of observations required to come to a decision when using G is never below the corresponding distribution function when using T, under either hypothesis.

15. CURRENT RESEARCH IN CROP AND LIVESTOCK ESTIMATING.

H. F. Huddleston; *U. S. D. A.*

The present program of the Agricultural Estimates Division, USDA, has been providing a large volume of agricultural statistics quickly and cheaply for the users of State as well as National data. The techniques now in use for making crop and livestock estimates on the whole are less costly than the newer sampling methods developed over the past several decades. More recently, the techniques in use have received considerable criticism and have been highlighted by the report of the Special Subcommittee of the Committee on Agriculture of the House of Representatives which investigated the cotton forecast of 1951. In particular, statisticians have raised

questions about the methods and urged the adoption of modern survey methods even though the costs will be higher.

Because of the importance of cotton estimates, large-scale pilot surveys were conducted in North Carolina and Mississippi throughout the 1953 season on a cross-section sample of cotton growers drawn from PMA lists. In addition, cooperative research with the Statistical Laboratories at Iowa State College and North Carolina State College were continued and expanded. The work at North Carolina State College was tied in with the cotton studies. Studies at Iowa State College were directed toward investigating the magnitude of possible reporting errors in farmers' reports of corn acreage and production. Farmers' judgment estimates are being compared with objective measurements on a small sample of farms through the middle of the State.

16. SOME PROBLEMS OF OPTIMUM SAMPLING.

Paul N. Somerville; *Virginia Polytechnic Institute*.

This paper attempts to apply some of Wald's theory of decision functions, and in particular minimax methods to problems of optimum sample sizes.

Let $\pi_0, \pi_1, \dots, \pi_k$ be $k+1$ populations identically distributed except for unknown parameters $\theta_0 \geq \theta_1 \geq \dots \geq \theta_k$. It is desired to choose N individuals from π_0 . A preliminary sample of n is taken from each population with the object of deciding which population is π_0 . Let $W(\theta_i, \theta_0)$ be the loss involved in choosing the population with parameter θ_i , where $W(\theta_i, \theta_0) \geq 0$, $W(\theta_0, \theta_0) = 0$. Let $C(n)$ be the cost of taking the preliminary sample. It is shown that under certain conditions, the maximum expected loss over all values of θ_i , $i = 0, 1, 2, \dots, k$ occurs where $\theta_1 = \theta_2 = \dots = \theta_k$. This enables us to find the maximum expected loss, which can then be minimized with respect to the preliminary sample size.

If the sample means of the $k+1$ populations are normally distributed, and it is required to maximize the expectation of the N individuals (θ_i is the mean of π_i), then if the cost of the preliminary sample is a linear function of its size, it is shown that the n which minimizes the maximum expected loss is proportional to $N^{2/3}$. Explicit results are given for $k = 1, 2, 3, 4, 5$, for a one-stage preliminary sample. For the case $k = 2$, results for a two-stage sample are given. In the first stage, samples of n_1 are taken from each of the three populations. In the second stage, samples of n_2 are taken from each of the two populations with the largest means in the first stage. If $3n_1 + 2n_2 = 3n$, then it is found that the maximum expected loss is less for the two-stage sample than for the one-stage sample provided n_1/n_2 is greater than .37 (approx.). The optimum ratio in this sense is found to be $n_1/n_2 = 1.2$ (approx.). If for this value of n_1/n_2 the maximum expected losses are equated by a reduction in the total sample size, a saving of 6.6 per cent over the one-stage procedure in the preliminary sample size is effected.

BUSINESS MEETING

The following were elected to serve as officers of the Section of Statistics for 1954-55:

Chairman--W. S. Connor

Vice-Chairman--M. C. K. Tweedie

Secretary--C. Y. Kramer

Editor--Lionel Weiss

A motion was proposed and carried to have the Statistics Section of the Virginia Academy of Science become a chapter of the American Statistical Association, to be known as the Virginia Academy of Science Chapter.

The Section voted in favor of having the *Virginia Journal of Science* carry a listing of papers and theses published by residents of the State of Virginia and members of the Virginia Academy of Science.

LIST OF MEMBERS

1953-1954

Note: Following are the types of membership in the Academy.

*^{**}Patrons, who contribute one thousand dollars or more to the Academy.
**Life Members, who contribute one hundred dollars or more to the Academy.

**Honorary Life Members (Elected by Council).

*Sustaining Members, who pay annual dues of ten dollars.

†Contributing Members, who pay annual dues of five dollars.

Regular Members, who pay annual dues of three dollars.

Student Members, who pay annual dues of two dollars.
(restricted to college students only).

Note: Number following name designates section, or sections, to which member belongs; "C" following name indicates "Student Member".

- | | |
|---|----------------------|
| 1. Agricultural Sciences | 7. Engineering |
| 2. Astronomy, Mathematics,
and Physics | 8. Geology |
| 3. Bacteriology | 9. Medical Sciences |
| 4. Biology | 10. Psychology |
| 5. Chemistry | 11. Science Teachers |
| 6. Education | 12. Statistics |

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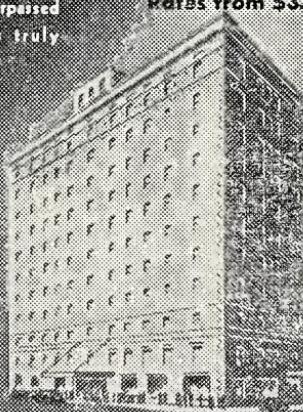
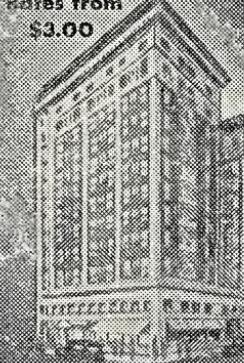
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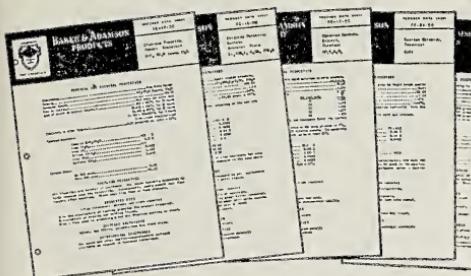


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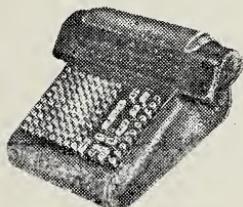
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